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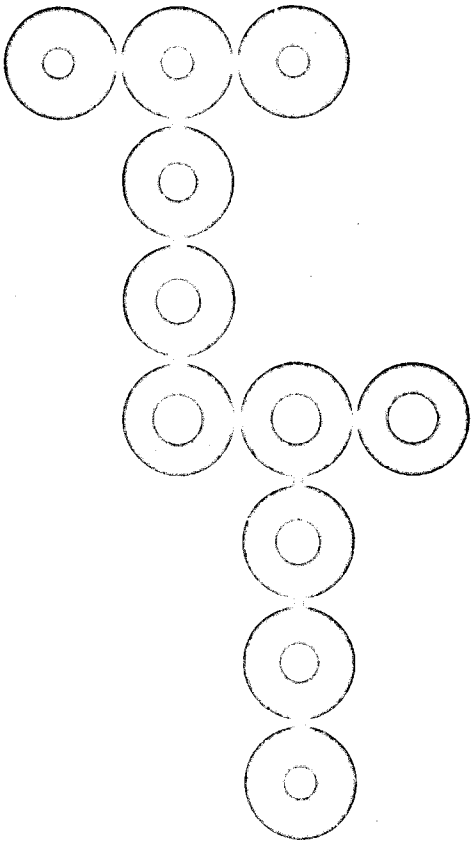

TECHNOLOGY TRANSFER PROCESS MODEL AND ANNOTATED SELECTED BIBLIOGRAPHY

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PREFACE

According to a U. S. Department of Commerce report (PB-263-806, p. 178), "It has been estimated that technological innovation was responsible for 45 percent of the Nation's economic growth between 1929 and 1969." Further, the report states, "A comparison of technology-intensive manufacturing industries with other industries in the period 1957 to 1973 shows that technology-intensive industries grew 45 percent faster and that employment in the technology-intensive industries grew 88 percent faster . . ."

Clearly then, the movement of technology from a source to a user is an important factor in the success of any enterprise or organizational activity.

Technology diffusion is defined as the unplanned movement from a source to a user. The technology diffusion process is quite slow. Studies have shown that it may take as long as 30 years for a new technology to permeate an industry on a world-wide basis.

In recent years, there has been considerable effort to enhance the movement of technology from a source to a potential user. This planned effort is most often referred to as technology transfer. In order to understand the factors that influence the movement of technology from the source to a user (technology transfer), it is necessary to study the human interaction process.

The material in the following pages is an organized analysis and presentation of the technology transfer process. The focus of the analysis is on the human interaction. A model is used as the basis of the discussion. The model provides a framework for a better understanding of the processes and concepts of technology transfer. By understanding the processes and concepts of technology transfer and their relationship to the individual in the organization, it is reasonable to expect that a manager can influence the likelihood that technology will move from a source to a user within a given organization.

The material presented is appropriate to be used as the basis for classroom discussion, seminar presentation, or simply as interesting and useful reading for a person interested in becoming more proficient at causing technology to move from a source to a user.

The annotations of articles and books are intended to provide useful information as well as serve as an explanatory guide to the referenced work of the authors.

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Monterey, California, U.S.A.
August, 1978

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INTRODUCTION

In this era of growing concern over the rational use of limited resources, one area is receiving increasing attention. That area involves maximizing the utility of the vast amount of technology and innovative information that has evolved in the past several decades. The focus of studies in this area has centered upon the process or method by which a potential user can most successfully avail himself of a given body of knowledge. Generally speaking, the problem is quite simple. Information merely need be transferred from the originating source to satisfy a need of an appropriate organization. In practice, however, the problem is as complex as the people involved. Furthermore, the new technology must often be adapted and reworked to suit the purposes of the using organization. As Lambrigh (1974, p. 11) noted when studying eleven cases of technology transfer, " . . . each incident of technology transfer contains a fascinating story full of technological complexity and human drama." Despite this staggering complexity of the transfer process, and primarily because of it, a potential user needs a model to employ as a tool to categorize, and deal with, the relevant variables impacting on a technology transfer effort. Developing such a model, and supporting it with the related literature, is our purpose here.

The Directory of Federal Technology (1975, p. V) offers one definition of technology transfer which adequately reflects the generality of the subject:

> *The process by which existing research is transferred operationally into useful processes, products, or programs that fulfill actual or potential public or private needs.*

Several important concepts can be noted from this definition. First, the term "research", as used in the definition, should be interpreted in its broadest sense to include developments in the many fields ranging from Aerospace to Mental Health to Education. The concern is that of taking an existing idea or body of knowledge, from any of these fields, and using it in a different place, in a different way. Presser (1969, p. 511) points out, while an idea is "a common practice in one area, it may be an innovation in another. An idea is an innovation at different places at different times."

The key word in the definition cited above is "process". Technology, ideas, and innovative information must be moved in a conscious, well contrived manner. No osmotic diffusion is likely to occur. Grubber (1976, p. 18) discussed the dynamics of the transfer process:

> *Technological change and innovation occur as the result of complex sets of human interactions, information flows and transfers, individual and organizational creativity, and individual and organizational risk-taking and decision-making.*

One method for putting the dynamics of technology transfer into a usable perspective is to begin discussing a "transfer mechanism". In simplified terms, the transfer process must include a set of activities designed to effectively link or couple the source of the needed knowledge with its eventual user. (See Figure 1) The transfer mechanism has been the topic of a great deal of research, study, and speculation. Rubenstein (1974, p. 254) lists eighteen distinct disciplines which have provided a multitude of propositions, models, and measurement methods dealing with the nature of the transfer process. He notes, however, despite all these contributions we are still in the "elephant and blind men" stage of this field. Cole and Gee (1973, p. iii) also reluctantly state, "Technology transfer remains primarily a localized process heavily dependent on seredipity and the predispositions of the principles involved." There appears,

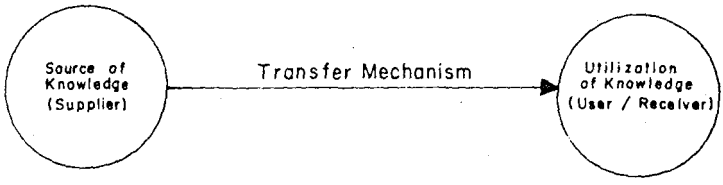


Figure 1 A Simplified View of the Transfer Mechanism

The transfer mechanism represents the interaction of people and need not be independent, but may be incorporated in either the supplier or user environment.

then, to be a growing need to tie together the research on technology transfer in such a manner so that it will aid practitioners in understanding the transfer mechanism.

The transfer mechanism can be envisioned as operating within the supplying organization (knowledge source), within the user organization (knowledge destination), or within an intermediary or brokerage institution. Perrin and Johnson (1972, p. 3) argue, "One of the major drawbacks of past and present transfer activities is that the problem has been approached from the developer's side of the fence . . ." In Gilmore (1969, p. 37), one of the conclusions reached was, "Past attention to technology transfer has focused on the supply side, future attention should focus on the demand side and on differences among user groups. Creighton, Jolly, and Denning (1972, p. 4) emphasized, " . . . given equal resources, and effective transfer mechanism in the user organization will produce a higher coefficient of technology utilization than an intermediary, third organization placed between supplier and user."

Though the research on technology transfer is abundant with references, like those above, which emphasize the primary importance of understanding the transfer process from the users standpoint, few models of the transfer mechanism exist which clearly incorporate this notion. That is not to say, however, that there is not an abundance of models in the literature dealing with technology transfer. *Putting Knowledge to Use* (1976) discusses in detail six widely quoted models, including those of Havelock, Davis, and Glasser. The point here is that these other models tend to take a detached system approach to the problem rather than concentrating on the issues and factors from the potential users side of the transfer process. One reason for this may lie in the manner in which the transfer process has traditionally been initiated and funded. Wright (1966) examined NASA's heavily funded program to actively transfer its technology. Despite efforts to catalyze and expedite commercial utilization of NASA technology, only 0.15 per cent of the potential transfer situations, and 5.5 per cent of nonnegative situations after determination of initial relevance, ultimately resulted in a successful transfer. NASA's experiences are typical for research agencies who have failed to perceive the multiplicity of the problem involved in identifying and fulfilling potential user needs. The consensus of the literature is apparently, "Successful technology transfer is a user or need oriented exchange concerned with relevance of both the technologies and their application." (Perrin and Johnson, 1972, p. 2) It is essential to realize the issue of relevance can only be answered from the potential users side of the transfer process.

The primary purpose of our effort in this paper and annotated bibliography, as stated earlier, is to present and support a model of the technology transfer process which not only has been developed from the potential users standpoint, but is well supported by the literature in this field.

The model delineates the factors composing the transfer mechanism, subdividing them into formal and informal factors. (See Figure 2.) The model was first published in Creighton, Jolly, and Denning (1972), and further investigated by Grubber (1976) and Neyenhuis and Welborn (1976), among others.

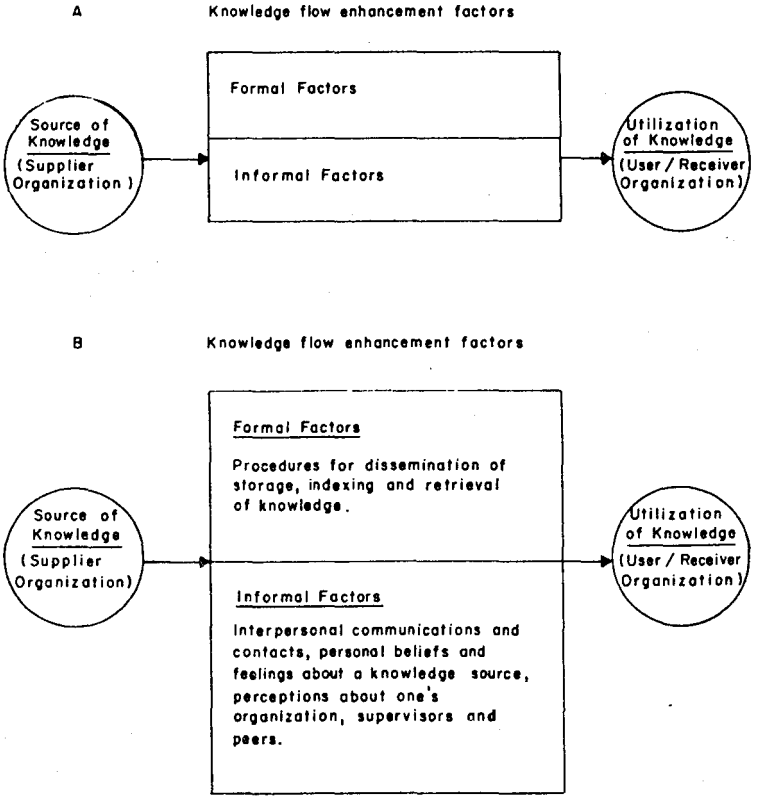
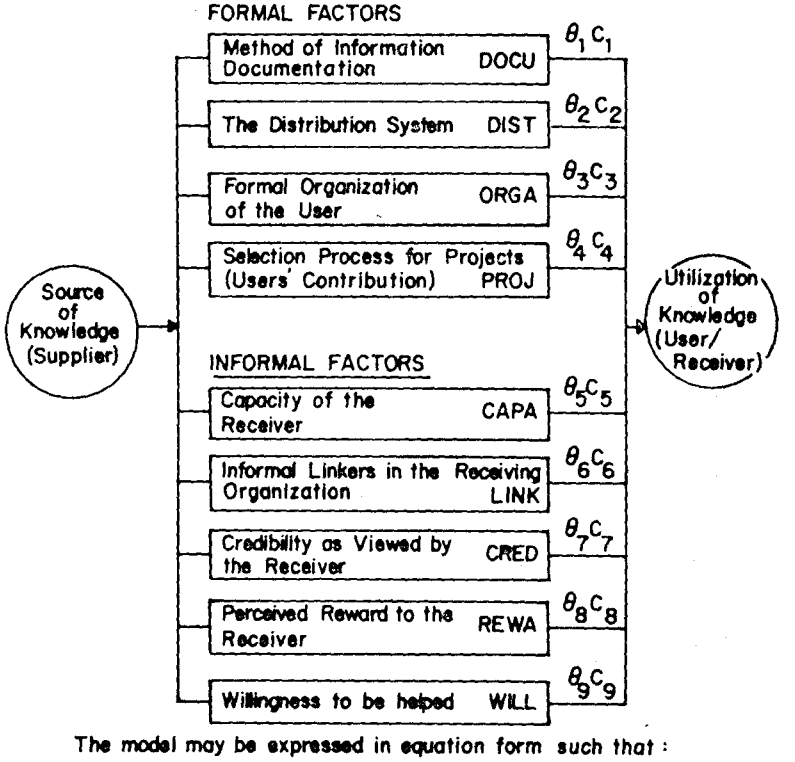


Figure 2 A Simplified Model of Technology Transfer

A. The movement of knowledge from the source to the user/receiver may be classified according to formal factors and informal factors.

B. The formal and informal factors are defined. The formal factors are procedural in nature, and the informal factors are behavioral.

The model is shown in Figure 3. To clarify the factors in the model, a detailed discussion of each will be given. The four "formal factors" are more tangible, objectively measurable, and subject to external control than the "informal factors." The way these factors impact upon decision-makers in the user or receiver organization determines whether they will be an aid or barrier to the transfer process.



The model may be expressed in equation form such that:

$$L_i = \Sigma \theta_1 C_1 + \theta_2 C_2 + + + \theta_j C_k$$

Where

L_i = Linker index for an organization i

θ_j = A measure of factor utilization, θ_j range $0 \longrightarrow 1$

C_k = A measure of the factor contribution, $\Sigma C_k = 1$

Figure 3 An Expansion of the Predictive Model of Technology Transfer

The factors in the predictive model have been grouped according to the classifications formal factors and informal factors. The factors classified formal are procedural in nature and the factors classified informal are interpersonal and/or behavioral.

Before proceeding further, the reader should be aware of the manner in which the selected annotated bibliography is arranged. Articles or reports dealing primarily with a given factor of the model will be so categorized in the bibliography under the appropriate section title. A section entitled "Multiple" has been included. It contains articles that are related to a good number of factors in the model and/or are deemed excellent introductory reading on the topic of technology transfer. At the end of the bibliography, a cross-reference guide is provided. Some articles are considered relevant to the discussion of several factors in the model, but rather than placing the annotation within each related section, they are cross-referenced between sections. An authors listing is also provided at the back of the bibliography to aid in locating specific articles or authors.

DISCUSSION OF THE ELEMENTS OF THE MODEL

DOCUMENTATION (DOCU):

This is the format, specifications, and presentation of the technology, or information being transferred. Format and language relate directly to the understanding of the material by the receiver. One cannot utilize information that one cannot understand. Reports should be designed to promote the desired behavior. (Aims, 1965) Unfortunately, as Howerton (in Cole and Gee, 1973, p. 27) points out, " . . . all disciplines are guilty of using their own argot and seem to be unable to understand why others cannot fathom the 'obvious' values of their discoveries. Technology cannot be transferred if it cannot be communicated in understandable form."

Documentation can take a variety of forms, which is appropriate depending on use preference and needs. Aims (1965) in a survey of 6,194 scientists found that abstracts were regarded as the most important tool for finding information. Reviews were used by 90% of the sample primarily for keeping up-to-date in the scientists specialty. Bottle (1965, p. 184) discusses the use of literature for current awareness needs. He argues that although reviews can greatly increase attention given to important papers, their preparation is "too lengthy a process' to get printed information to potential users. Menzel ((1964) further discusses the problem of inadequate documentation in meeting information needs.

The producer or supplier of technological data must be concerned with selling his product. As Brooks (1967, p. 1712) points out, "Good research is of little value if the mechanism does not exist to translate research results into goods, services, or operations." Decision-makers in receiving organizations are a very selective audience. "Their time is valuable, and competition for attention intense. They demand a concise, articulate presentation, and they respond to brevity, force, and attractive display." (Tressel in Cole and Gee, 1973, p. 30) To sell their technology, suppliers have no choice but to adjust documentation to their efforts to suit the needs and character of the user. "Refining, packaging, and selling technology should receive more attention." (Gilmore, 1969, p. 37)

DISTRIBUTION (DIST):

This factor is the physical channel through which technology flows, involving both the number of entries and ease of access into the channel, as well as the formal distribution plan as it impacts on the information user. In his survey, Aims (1965, p. 88) found that 28% of the scientists studied had encountered delays in their research owing to their ignorance of previous or current research. This certainly emphasizes the importance of an effective knowledge distribution system.

Allen (1966, p. 11) did a comparative analysis of eight specific message channels. He found that although three times as many suggestions of solution alternatives to technical problems came from resources external to the project group, use of these channels were inversely related to the performance of the group at reaching solutions. This difficulty and inadequacy of using information distribution or dissem-

ination sources to obtain usable ideas is further highlighted by Foster. (1971, p. 35) He points out that when using computerized reference banks, such as STAR, SDE, or NTIS, ". . . a realistic expectation is one good idea for every 1,000 titles obtained from the initial investigation."

Computerized information systems have developed considerably over the past decade. Licklider (1966) presents a good argument for using computers to transform the "flood" of scientific information into applicable knowledge. Overly (1966, p. 40) discusses an "action program" wherein information service entries offer a spectrum of specialized services ranging from ". . . a proprietary problem solving approach to generalized current awareness programs." Knox (1973, p. 415) lists among the most important changes in the technological system in the past 15 or 20 years the development of the computer, electronic display devices and microforms, and the creation of computer based files of abstracts and indices for specific subjects with subsequent distribution to specific user groups.

Apparently, increased efficiency of information systems have aided in the accelerating technology transfer process, but has not impressively, in itself, multiplied the number of successful transfer incidents. As cited previously, Wright (1966, p. 35), observed this in studying NASA's active information dissemination program. Some of the complexity and shortcomings of information distribution programs are noted by Bottle (1965). He illustrates that until the literature concerning a given piece of technological information becomes commercially important enough for specialized journals, the literature " . . . is very difficult to locate as one does not really know what to look for." Furthermore, he points out, " . . . even though the epoch making paper is picked up by abstracting services, the indexes may fail to realize its significance and no entries for it will appear under really significant headings."

Engel, Blackwell, and Kegerreis (1969, p. 7) studies how information is used in the innovation adoption process. Their findings indicated that active information distribution programs played an important role in " . . . stimulating awareness and initial interest." They found also, that personal contact was the most influential source of information in inducing innovative behavior. Interpersonal communications clearly plays an instrumental part in the information distribution process. Aims (1965, p. 86) in his survey of the information needs of 6,194 scientists concluded that they " . . . might well benefit from a better network of personal contacts." Menzel (1964, p. 14) stated, "All the possible ways of classifying content cannot possibly be taken into account in the organization of journals, in the indexing and abstracting services, or even in the selection of the title of papers. Any given researcher must depend largely on friends who work in adjoining specialties, yet know what is of interest to him, to point out the pertinent material to him."

An information distribution program is an essential and inescapable factor in the technology transfer process. For the coupling of a problem with a solution to occur, information must move through some channel, be it interpersonal or computer assisted, by journals, or another vehicle. The method in which information is disseminated is especially important when the transfer process is viewed from the supplier or an intermediary agency's standpoint. The distribution policy is one of the few factors in the transfer mechanism which can be actively manipulated. (Brown, 1966, p. 3) It is essential to understand, however, no matter how elaborate, expensive, and energetic a distribution policy may be, this is only one of the factors which will determine the success of a technology transfer effort.

ORGANIZATION

This is the impact that the formal organization of the potential technology user has upon a transfer effort. Under the title *Formal Organization*, one would consider such things as the rules, norms, and role structure of a specific company, business, or governmental agency. Kogan (1963, p. 574) chooses to expand the idea of an organizational setting even further, to in-

clude such factors as "... the priorities of different aspects of a program, the timeliness of introducing a modification in policy or practice, and the cost of new as compared with established procedures . . . " The importance of organizational setting is stressed by Churchill and Ozanne (1967, p. 19), who concluded, "The characteristics of the firm and of the decision making group should account for variation in the dimension of the industrial adoption process." This conclusion is supported by Baker (1967, p. 162) who found, " . . . knowledge of organizational problems, needs, and opportunities stimulated 75% of ideas."

Schon (1967, p. 63) discusses the nature of the "corporate society" which is typically created by a formal organization. "The corporate society, like all societies, is in a state of dynamic conservatism. It strives for survival, stability, and continuity. It is active in its efforts to achieve its objectives and to maintain its society, structure, functions, values, language, and style of operation."

Thus, a formal organization may establish bureaucratic tendencies which tend to dynamically obstruct change and innovativeness. The determination of an attitude to accept or reject change by a formal organization can produce an insight into the organization's expended utilization of new and/or innovative ideas. Wells and Waterman (1964, p. 118) stress that for a company to overcome resistance to change it is critical that management provide an organizational environment which motivates members to be innovative. Lingwood and Morris (1976) likewise emphasize the impact of organizational conditions in providing a good research environment.

Grubber (1976, p. 30) stated, "Change is the way of life. Resistance to change is also a way of life. The only way that successful change can take place is to overcome the resistance to it and provide the proper organizational conditions to enhance it."

Informal relationships and communication networks that are allowed to perpetuate by the formal organizational structure are most often cited as the key to overcoming resistance to change. Barth (1970, p. 306) found a significant correlation between informal intergroup climate and an organization's problem solving ability and communications problems. The geographical location of key organizational members, the functional organization structure, and architectural design of the physical facilities are important variables which impact upon organizational effectiveness. (Allen, 1970, p. 21) In addition, the most effective work conditions need contain "creative tensions". (Pelz and Andrews, 1966, p. 259) Schon (1976, p. 134), further characterized an organization that is favorable to technology transfer and utilization of knowledge as living in a state of pressure to perform where conflict is resolved by feat, where resources are committed without hesitation, and where uncertainty is converted to risk.

When considering the position of the potential technology of the potential technology user, in the overall scheme of a transfer effort, i.e., from a macro standpoint, a very real and favorable problem must be confronted. That problem is "organizational boundary impedance." As discussed by Allen (1966, p. 1) this impedance occurs because "... the members of industrial and governmental organizations acquire through common experience, and organization imposition, shared coding schemes which can be quite different from the schemes held by other members of their particular discipline." Linkage between organization, as discussed later, is one way to circumvent this problem. Still, managers must be aware of the problem and strive to develop appropriate measures in their organizational design to keep it open to technology transfer opportunities.

PROJ

This factor refers to the selection process for research development undertaken by the source and the receiver's contributions to that process. Besides the obvious benefit of increasing the potential utility of research through such collabora-

tion, potential users or receivers become more committed much earlier to the technology transfer effort. Kogan (1963, p. 573) states, "... it is commonly accepted that research has a better chance of being used if researchers, practitioners, and administrators have participated at every stage of the planning, execution, and interpretation of the research.

Two authors have shown that, "... a basic reason for the lack of research utilization is that the process is often begun with the research process rather than the client's needs." (Rogers and Jain, 1969, p. 9) For firms interested in adopting new technology, the findings of Utterback (1971, p. 131) further suggest, "... integration of market and economic information with technical information and analysis and communicating needs and problems appear to be critical in generating ideas for new products." Haglund and Schlie (1975, p. 12) make it clear that if collaboration on a project by key participants does not take place, the laboratory will likely over or under innovate for what the user really requires.

The distinction between applied versus basic research is frequently made by laboratories and other research facilities in project selection and design. Applied research, almost by definition is dependent upon user input for validity. As Brooks (1967, p. 1708) points out, "Applied research is most effective when it is coupled to a 'market' that provides an automatic measure of effectiveness of the end product of research." Garner (1972) carries this argument one step further and illustrates, "... it is just as valuable for scientists doing basic research to have communications with the people who have problems that need solutions." He agrees further, "... for scientists to engage in goal oriented research, research aimed at solving problems already known to exist is both to perform a service to society and to improve the quality of the basic research itself."

A functional relationship between the research facility and potential technology user is clearly an extremely effective way to circumvent many of the barriers to a transfer effort, especially with respect to technology relevancy, applicability, and marketability. A clear example of this was an experiment conducted by the UTS (1976) to test methods to overcome barriers to local government technological innovations. The results of their efforts indicated that the key to successful technology transfer was the coupling of local government needs with R&D facilities and the technical community. Similarly Havelock (1971, p. 150) in studying the National Highway Traffic Safety Administration concluded R&D efforts would be optimized if they were integrated into a "problem solving system."

Not every organization is in a position to provide input to R&D facilities as a given technology is being developed. A considerable amount of useful technology has been developed and remains "on the shelf" until a user need is identified. Still, as emphasized earlier, innovative technology is rarely directly transposable from the R&D facility to the user, or even from one user to another user. If a member of an organization identifies a certain technology that matches their need or market opportunity, it is still essential that they locate the persons or R&D facility that had the most to do in developing the technology to help adopt it to their specific purposes. (Foster, 1971, p. 35) Therefore, the importance of user input to the R&D facility, or knowledge source, appears important, regardless of the stage of development of the needed technology.

INFORMAL FACTORS

Throughout the discussion of the model for technology transfer developed in this paper, one central theme should be kept in mind. Our focus is upon the people who work within the receiving organization, their needs, idiosyncracies, and impact upon a technology transfer effort. These individuals, no others will ultimately determine whether technology transfer will successfully occur. The preceding delineation of the "formal factors" in our model attemped to illustrate those factors often external to the potential users control, which weigh upon his ability to adopt a new technology.

The informal factors of the model, in contrast, are presented as a behavioral and/or sociological segment in the same model. These factors include individual traits, capabilities, perceptions, and predispositions which are especially pertinent to a technology transfer effort.

CAPA

This factor refers to the ability and capability of the potential user to utilize new and/or innovative ideas. Studies in this area have centered upon isolating the personality traits and behavioral characteristics of innovators, i.e., those with the capacity to be early adopters of new practices and ideas. Within a receiving organization, innovators serve as demonstrators of new practices. (Havelock,1971, pp. 7 - 13) Their contribution to the transfer effort is paramount in importance. They will be the first in an organization, by definition, to give a new technology a try. As stated by Rogers (1961, p. 92) innovativeness is " . . . the degree to which an individual is relatively earlier to adopt new ideas than the other members of his social system." Presser (1969, p. 514) likewise emphasizes that when identifying innovators, " . . . the time of adoption or firstness notion is crucial." Thus, by isolating socio-psychological attitudes of innovators as a group in general, one can predict whether a specific potential user has the capacity for innovativeness and, consequently, the ability to adopt a new technology. Furthermore, by establishing who has the capacity for innovativeness in a given organization or group, the best target for a transfer effort can be determined.

Rogers (1958, p. 349) categorized individuals into five adopter groups: innovators, early adopters, early majority, late majority, and laggard. For a given innovation, the first 2.5% of the individuals to adopt it were classified as "innovators." Rogers (1961) in studying 164 Ohio farmers and a sample of 99 innovators established that innovativeness was negatively related to age and positively related to social status, years of education, size of the business, business income and specialization, outside communication, and opinion leadership. Robertson (1970, p. 108) further was able to predict innovative behavior using the pre-dispositional variables of venturesomeness, social integration, cosmopolitaness, social mobility, privilegeness, interest polymorphism, and personality. Loy (1969, p. 77) also extended the work of Rogers by investigating the prediction of innovativeness. One hundred and six respondents completed a questionnaire and interview covering seventeen socio-psychological attributes. Six attributes (venturesomeness, professional status, imaginativeness, educational status, dominance, sociability, and cosmopolitaness) were significant at the 0.01 level (# test). A seventh attribute, self-sufficiency, was significant at the 0.05 level. The attributes that did not appear important were perseverance, peer status, intelligence, occupational status, social status, shrewdness, experimentiveness, surgency, and sensitivity.

Though the central issue on user capacity has been upon the traits of innovators,other important variables in the transfer mechanism fall under this heading. Churchill and Ozanne (1967, p. 19), for example, discuss the capacity of the decision-making group as a dimension in the adoption process. Pelz and Andrews (1966, p. 259) in a six-year study, isolated factors which are indicative of a work group's capacity to be productive. In general, the capacity of the user, as a part of the model, should not be interpreted as only an issue of identifying innovative behavior, but a matter of giving due recognition to the significance of the capacity of all the key players and groups in an organization attempting to adopt a new technology.

LINKER

This refers to the presence of, and effects of, individuals in the receiving organizations who link or couple their organizations to the larger environment. Specifically, these individuals operate within the same organization or social system as those parties who will actually use the new technology, filling the roles of leader (gatekeep-

er and opinion leader), early adopter of an innovation (innovator), and early knower of an innovation. (Creighton, Jolly, and Denning, 1972, p. 10) Because the research and user communities are separate problem solving systems, a two-way communication linkage is required between them as a prelude to research utilization. (Havelock, 1974, p. 45) The linker, then, " . . . mediates between his organizational colleagues and the world outside, and he effectively couples the organization to scientific and technological activity in the world at large." (Allen, 1970, p. 13) As the opinion leader, it is the linkers function to bring his group into touch with the relevant part of the environment through whatever media are appropriate. (Katz, 1957, p. 77) If he is to be effective, his role becomes: "To link by taking initiative on ones own behalf to seek out scientific knowledge and derive useful learning therefrom." (Havelock, 1971, p. 7-4a)

The primary way linkers obtain their information is through "informal, interpersonal channels of communication." Farr, 1969, p. 2) Czepiel (1974, p. 178) in studying the diffusion of major technological innovations among business firms found, " . . . a functioning informal community linking together the firms." This is consistent with the findings of Katz (1957, p. 77), who concluded, " . . . despite their greater exposure to the media, most opinion leaders are primarily affected not by the communication media but by still other people."

A linker typically operates as a "gatekeeper" or the individual who is in the strategic position to control and filter inputs into his organization. (Havelock, 1971, pp. 7 - 11) As stated by Lewin (1943, p. 37), "Entering or not entering a channel and moving from one section of a channel to another is effected by a gatekeeper." Most importantly, it is through the gatekeeper that one obtains access to the receiving organization and its channels of interpersonal communications. (Farr, 1969, p. 10) The gatekeeper is not only in the position to be selective about the information which will enter his organization but he is typically the one who will make it available to other organizational members including the potential user. Conversely, because the gatekeepers orientation is toward outside sources, he is the key individual within an organization or group upon whom others rely very heavily for information. (Allen, 1970, p. 16)

CREDIBILITY

Credibility is the receiver's assessment of the reliability of the information before him. It is evaluated as a factor in the model by analyzing both the source and channel of the message. Because individuals have difficulty distinguishing between the source or origin of a message on the channel which carries that message to him, the individual will attach a composite credibility to a message derived from both perceived source and perceived channel.

Gallup (1955, p. 235) stated, "The character of the group most closely concerned or identified with the idea will be an important factor in determining how fast it gets into the blood stream." This conclusion is supported by the experiments of Kiesler *et al.* (1974, p. 1047), who found that perceived "legitimacy" of the speaker was a powerful determinant of attitude change. Hoveland (1952, p. 647) in addition concluded that the value placed on a communication is significantly affected by an individual's evaluation of "trustworthiness" of the source. Aronson *et al* (1963, p. 3), in an application of cognitive dissonance theory, showed by a laboratory experiment that opinion change was unequivocally a factor of the creditibility of the source. Among their findings they note, "It is apparent that the highly credible communicator was more successful in inducing opinion change than the mildly credible communicator at every point of discrepancy (from the receiver's initial opinion)."

The criteria actually used by receivers in evaluating the message source was studied by Berlo *et al* (1969, p. 574). They identified three meaningful and statistically independent dimensions of source credibility: safety, qualification, and dynamism. Griffin (1967, p. 107) further

identified five characteristics of the communicator which are perceived by message receivers as important in determining source trustworthiness and credibility. These perceived dimensions of the communicators image are expertness, reliability, intentions, dynamism, and personal attraction.

Zimbaro *et al* (1965, p. 252) noted that in interpersonal communicating situations, " . . . attitude change is often mediated by a host of physical, social, and psychological traits of the influencing agent." Their studies underline the significance of the message channels contributors toward perceived credibility. Communicators were found to be able to influence attitude change, " . . . without specifically communicating persuasive arguments and conclusions."

In the typical work schedule of the potential user of a new technology, he is confronted by information through many channels and from many sources. (Allen, 1966, p. 20) How he reacts to that information and whether or not he decides to adopt it into his organization are considerably affected by the credibility he attaches to both the carrier and source of the message.

REWARD

This factor refers to the perceived and the social system of which the individual is a member. As Lingwood and Morris (1976, p. 121) commented, "Obviously, rewards are the glue which holds organizations together and provide the response to individual needs for recognition of accomplishment . . . no research is going to get very involved in application work if he does not see a predefined and operating system of rewards for such work." Nyenhuis and Welborn (1976, p. 48) further found that how the reward structure of an organization is perceived by an individual will have a great impact on idea flow and " . . . will determine in large measure his willingness to initiate idea transmission."

Pelz and Andrews (1966 p. 139) divide reward achievement into two broad categories: "Reward intrinsic to the work itself (such as opportunity to use skills, to gain new knowledge, to deal with challenging problems, and to have freedom to follow up one's own ideas) and those extrinsic to the technical content (a good salary, higher administrative authority, association with top executives." Intrinsic rather than extrinsic rewards apparently have considerably more strength as a motivator for most individuals. Extrinsic rewards, such as money, may even have a negative impact by working to " . . . buy off ones intrinsic motivation for an activity." (Deci, 1971, p. 114) Extrinsic reward is apparently appropriate, however, when men are asked to accept a change that they fear deprives them of something. (Maier and Hoffman, 1964, pp. 376 - 77) Grubber (1976, p. 14) suggests effective extrinsic rewards for innovative behavior include actions through ratings, in-house publications, awards by professional societies and allocation points toward promotion. Intrinsic motivation has been found to increase with verbal reinforcement and positive feedback in a problem-solving activity (Deci, 1971, p. 377) and when there is recognition by colleagues. (Peters, 1975, p. 17)

Although there is clearly a difference in the appropriateness and perceived importance of intrinsic versus extrinsic reward, neither can be ignored. The concept and construct of a reward system is summarized by Pelz and Andrews (1966, p. 139): "The implication is that the research director (or manager) must give close attention to the whole system of rewards — both intrinsic and extrinsic. He must hire with the paradox that extrinsic rewards cannot be relied upon to motivate achievement, but that when achievement occurs, the extrinsic rewards should be consistent."

WILLINGNESS (WILL)

Willingness relates to the individual's ability and/or desire to accept change in the organization of which one is a member. Opposition to change is normal. It is wrong to assume that a blind reaction to technological change springs exclusively from some "causeless Bourbon distemper" that invades the mind. Opposition to

change occurs because of a "normal human instinct to protect oneself and more especially one's way of life." (Schon, 1963, p. 82) Gallup (1955, p. 233) pointed out, "Persons with vested interests, if there be any, will see to it that mental road blocks are put in front of every new idea which deprives them of prestige or power." Berlin (1964, p. 115) further concludes that individuals resist change because, " . . . such change may reduce their status, financial return, sense of personal satisfaction, and feelings of competency." Wright (1966, p. 35) discovered that organizations were much more willing to take advantage of NASA technology if there was only minimal disturbance to their industrial equilibrium. Many new and potentially profitable ideas were being rejected because of the "not-invented-here syndrome." (Pearson and Richards, 1974, p. 67) Thus, resistance to technological change is a major barrier in a transfer effort, and " . . . a willingness to face the price of innovation is a major part of the problem of technological progress." (Schron, 1963, p. 86)

Gallup (1955, p. 232) studied the adoption rate of ideas. He concluded that although an idea may have been accepted intellectually, normally a long period of time passes before it is incorporated into the thinking of the person who has accepted it. Berlin (1969, p. 112) expands on this finding by noting that, " . . . resistance to change sometimes takes the form of acknowledging the relevancy of new ideas and methods but not accepting them in practice or trying them out fully in new training and practice areas." As emphasized by Cetron (1974, p. 17), "It is important to remember that technology transfer not only means transferring knowledge but also refers to the application of that knowledge . . ."

Awareness then, even firsthand knowledge of a new and/or innovative idea, is not sufficient to assure its use. There must be a willingness and interest or perhaps more significantly an internal motivation to utilize a better method, process, or concept.

PART II

ANNOTATED SELECTED BIBLIOGRAPHY

MULTIPLE SUBJECTS

Bhola, H. S., "A Theory of Innovation Diffusion on Its Application to Indian Education and Community Development," (Doctoral Dissertation: Ohio State University), Ann Arbor, Michigan: University Microfilms, 1970, No. 66-6230.

The theory presented is designed to explain the process of innovation diffusion and *predict* success or failure of innovation diffusion plans and projects. The Configurational Theory of Innovation Diffusion is stated by the function:

$$D = f(C_{ij} \; LER)$$

In descriptive terms, Diffusion (D) of an innovation is a function of the configurational relationship (C) between the Initiator (i) from a class of such initiators and the Target (j) from a class of such targets; the extent and nature of linkage (L) *between* and within configurations; the Environment (E) in which the configurations are located; and the Resources (R) of both the initiator and target configurations.

This paper is a uniquely presented multi-variate approach to the "linking model." The author comments, "The practitioner in the field of innovation does not find much research in his own area. There are as yet no useful research findings, no evaluated methods."

Gilmore, J. S., ed., "The Environment and Its Action in Technology Transfer, 1970-1980," Denver Research Institute University of Denver, September, 1969.

The 35 participants in the conference represented both suppliers and users of technology, and observer-researchers of the TT process. The conclusions they reached after the 2-1/2 day conference were:

1. "Further development of technology transfer system should focus more on people than on hardware." Printed information was said to be less effective than the transfer of people with the required knowledge, face-to-face communication, "show and tell" demonstrators or similar techniques.

2. "Refining, packaging, and selling technology should receive more attention." There is a need for broker groups between sources of relevant technology and potential users; existing innovations need to be targeted to specific kinds of users.

3. "Past attention to technology transfer has focused on the supply side; future attention should focus on demand side and on differences among user groups." Ways must be developed to understand and then strengthen forces which will motivate the user to discover and adopt appropriate technologies, improving the environment for technology transfer.

4. Motivation for TT need to be enhanced, particularly in the public sector.

5. The value of selected technologies for solving societal problems should be endorsed by high level leadership.

6. The environment for TT should be created or modified through education and reward mechanisms. "The challenge for the 1970's will be to conquer the barriers to diffusion, transfer, and innovation in the public sector."

Grubber, J. A., *Utilization of Technology Transfer Concepts as an Aid for Engineering Management in a Test and Evaluation Organization.* Master's Thesis, Naval Postgraduate School, Monterey, California, September 1976.

A good multi-factor analysis of the technology transfer process. Though the end purpose of this thesis is to develop a paradigm for action for the middle management T&E engineer to improve technical capability, the discussion and recommendation have a cross-discipline applicability. Some of the chapters in the text include: Barriers to Technology Transfer, Factors Aiding Technology Transfer/Innovation. The Importance of Information Channels in TT, Characteristics of Innovators/Adopters, and Linker Characteristics.

The author's review of the literature generally gives substance and clarity to the Creighton, Jolly, and Denning (1972) Theoretical Model for Technology Transfer. A favorable representation of points stressed by the author follows:

"Technological change and innovation occur as the result of complex sets of human interactions, information flows and transfers, individual and organizational creativity, and individual and organizational risk-taking and decision-making."

"Change is the way of life. Resistance to change is also a way of life. The only way that successful change can take place is to overcome the resistance to it and provide the proper organizational conditions to enhance it."

"Reward innovative actions through ratings, in-house publications, awards by professional societies, releases to local news media, and allowing points toward promotion for innovative behavior (within regulations).

Havelock, Ronald G. and Markowitz, Elizabeth A., "A National Problem-Solving System: Highway Safety Researchers and Decision-Makers," prepared for National Highway Traffic Safety Administration, U. S. Department of Transportation, Contract No. FH-11-6900, May 1971.

An interesting and informative case study on "how a society works on an important social problem." The authors, methodology, findings, and analysis illustrate the multiplicity of factors involved in technology transfer and utilization. Highway safety is shown to be a Problem Solving System." Research opinion leaders were found to form a bridge between the R&D community and decision-makers. Recommendations for improving the system included:

1. "Improve the linkage between and among researchers and decision-makers" by, among other things, utilizing opinion leaders, establishing and supporting a "national safety research information clearing house," and support annual conferences with published proceedings on critical topics.

2. Work to optimize the problem-solving system.

3. Increase the total R&D effort.

Havelock, R. G. and Lingwood, D. A., "R&D Utilization Strategies and Functions: An Analytical Comparison of Four Systems," Ann Arbor, Michigan: Institute for Social Research, University of Michigan, 1973.

Four governmental agencies are compared on the basis of the Research Diffusion and Utilization (R&U) units they have established. The authors develop a 6-point theoretical model which describes a resource-user, problem-solving dialogue within which they claim it is possible to analyze all functions and activities of D&U agencies. A ten-part rating schema for diagnosing D&U problems (H.E.L.P.S.C.O.R.E.S.) is also developed and applied to the governmental agencies. Communication network maps are presented which include types of information, media, and flow among key sub-groups. Other findings include:

1. Attitudes toward D&U are dominated by four ideologies best characterized by the phrases "communicate and collarborate" (linkage); "help the user where he is at" (user centering); "plan and organize systematically: (RD&D)"; and

"invest heavily" (capacity).

2. Linkage is the most important procedural element in the D&U system and the most cited target for system improvement.

3. Adequate diagnosis of the real user need is the second most important element in the D&U system.

4. Carefully organizing the D&U system to achieve linkage and user relevance is the third most important procedural element and target for improvement.

Though this work deals primarily with linking institutions, insights can be gained about both the behavioral and procedural factors effecting knowledge flow and knowledge utilization.

Havelock, R. G., "Ideal Systems for Research Utilization: Four Alternatives," Washington, DC: Social Rehabilitation Service, U.S. Department of Health, Education, and Welfare, March 1974.

A 480-page commissioned report which contains four alternate research utilization model designs. Three of the designs come from Edward M. Glaser, Ronald Lippitt, and Everett M. Rogers. The fourth is by the principle investigator (R. G. Havelock), and designed to synthesize the best ideas of the other three and to represent, wherever possible, a "consensus view."

This vigorous effort presents a valuable presentation of the work of some of the major contributors to the investigation of technology transfer. Among their synthesized findings and conclusions are the following:

1. A research utilization system is comprised of eight component elements —

   A. need sensing, activating, and communicating;

   B. knowledge production;

   C. knowledge storage and scanning;

   D. knowledge processing;

   E. dissemination;

   F. utilization;

   G. evaluation of the system, its impacts; and

   H. integration of the system and its components. (A - G above)

2. Eight operational modes for research utilization, rather than a single preferable system, are discussed. The research and user communities are viewed as separate problem-solving systems requiring two-way communication linkage between them as a prelude to "research utilization." The function and interrelationship of eight modes is charted in detail. The modes as listed are:

   A. coordinated mission-oriented R&D program;

   B. R&D product dissemination service;

   C. continuous flow dissemination;

   D. natural network nurture;

   E. knowledge-based, problem-solving consultation service;

   F. instant response R&D retrieval service;

   G. rapid response R&D report service; and

   H. user-centered R&D report service.

Lambrigh, W.H. and Teich, A.H. *et al*, *Federal Laboratories and Technology Transfer: Institutions, Linkages, and Processes.* A Collaborative Project of the Policy Institute, Syracuse University Research Corporation and the State University of New York at Binghamton, under National Science Foundations contract #C832, March, 1974, 347 pages.

Eleven cases, covering a range of technology transfer experiences, are presented by developing a descriptive analysis of the sequence of events in the transfer process from the point at which the idea was conceived up until this article was written. The authors believe each of the cases "contains a fascinating story full of technological complexity and human drama."

This study is based on a conceptual model where basically four functions are seen as involved in the TT process: "innovation" — the creation or adaptation of the technology; "manufacture" — the production of the technology for sale; "utilization" — the acceptance and employment of the technology; and "brokerage" — bringing the other three functions together. The model used hypothesizes that "the development of early, formal linkages among the actors representing these functions . . . is essential to the eventual success of the transfer."

Among the multitude of interesting conclusions and insights gained from the case studies is the following: "Federal laboratory technology, no matter how useful to public programs, will remain on the shelf unless it is consciously moved and appropriately adapted by people and institutions with motivation, skill, and access to resources."

Pelz, D.C. and Andrews, F.M., *Scientists in Organization*, New York: John Wiley and Sons, Inc., 1966, 313 pages.

A six-year study to determine what constitutes a stimulating atmosphere within research and development organizations. Information about technical performance, work relationships, and motivations was collected from 1,300 scientists and engineers. The authors address chapters to twelve different variables and characteristics of an R&D organization, among are: Freedom, Communication, Diversity, Dedication, Motivations, Satisfactions, Creativity, and Age. In general, scientists and engineers studied did effective work under conditions that were not completely comfortable, but contained "creative tensions" brought on by forces pulling in different directions. Some of the broad features which characterized the environment of the most productive scientists and engineers were found to be:

1. Effective scientists were self-directed by their own ideas and valued freedom. But at the same time, they allowed several other people a voice in shaping their directions; they interacted vigorously with colleagues.

2. The work of effective scientists were diversified between the worlds of "application" and "pure science."

3. The interests of effective scientists was not fully in agreement with the organization's, thereby sometimes impeding their advance in the structure.

4. Effective scientists tended to be motivated by the same kinds of things as their colleagues, but differed in the styles and strategies with which they approached their work.

5. In effective older groups, the members interacted vigorously and preferred each other as collaborators, yet they held each other at an emotional distance and felt free to disagree on technical strategies.

Perrin, J. R. and Johnson, C. A., "Active Technology Transfer," American Institute of Aeronautics and Astronautics (AIAA) Paper No. 72-1105 (New York: Technical Information Service), given at AIAA/SAE 8th Joint Propulsion Specialist Conference, November 29 - December 1, 1972.

This brief paper provides an excellent overview of the technology transfer process. The authors argue that intermediary transfer agents (middlemen) are necessary to establish communication links between the developers and potential users of a given technology. They point out that:

> *Successful technology transfer is a user or need oriented exchange concerned with relevance of both the technologies and their application. This activity requires personal communications by individuals skilled in identifying, evaluating, packaging, and disseminating technology information.*
>
> *Multi-million dollar programs in formation storage and retrieval services, regional dissemination centers, computer searches, and related passive efforts do not effectively transfer technology or initiate civil agency interest or coordination with developers of technology."*

They further illustrate:

> *One of the major drawbacks of past and present technology transfer activities is that the problem has been approached from the developer's side of the fence . . . what is required is the industrious participation by the civil agencies in thoroughly defining the problems to be solved and seeking out developed technologies for their solution.*

Because user organizations are not doing this, the authors argue, a formalized activity should be established where transfer agents are placed in the supplier organizations to provide a direct link between the laboratories and user industries.

Putting Knowledge to Use: A Distillation of Literature Regarding Knowledge Transfer and Change, a Collaborative between the Department of Health, Education, and Welfare and the Human Interaction Research Institute (Los Angeles, CA), 1976, 451 pages, (Coordinated by Glaser, E. M.)

Undoubtedly, one of the most comprehensive reviews of the literature on the secondary utilization of knowledge-innovative behavior and organizational change. Two hundred and sixty-seven summaries of selected literature are given. In addition, over 1,000 entries appear in the bibliography. The first 76 pages of this document are broken into 6 chapters, which attempt to tie together the major research efforts dealing with knowledge distillation. Titles of these chapters include: *Determinants of Knowledge Utilization, Stages in the Process of Knowledge Utilization, Research-Practice Linkage: Dissemination and the Change Agent*, and the *Search for Models of Research Utilization.*

Though the NTIS apparently was not used extensively for input to this document and the biases of Head of the Human Interaction Research Institute, Dr. Edward Glaser have in ways influenced the selection of material, this work is an excellent "handbook" of the literature dealing with knowledge utilization. Knowledge utilization, as a field of study, is described as dealing with:

1. developing insights on the part of both knowledge producers and knowledge users into the underlying processes of knowledge development, dissemination, and implementation;
2. identifying factors that account for delay in adaptation or adoption following the development stage; and
3. generating strategies or measures for enhancing appropriate and timely utilization.

Rubenstein, A. H., "Basic Research on Technology Transfer," in *Technology Transfer*, Proceedings of the NATO Advanced Study Institute on Technology Transfer, June 24 - July 6, 1973, ed., H. F. Davidson, *et al*, Leiben, The Netherlands, Nordoff International Publishing, 1974, pp. 247-266.

This article is directed at delineating and discussing the kinds of efforts being devoted to investigating and improving the technology transfer process. Although the target audience of this work is the researchers upon TT, new readers on this topic can gain some insightful information. In particular, the author shows that there is little comparability and convergence in the research currently being done. His illustrative examples of the range of variables and propositions which form the basis of research studies point this out. Four issues concerning TT research design are dealt with:

1. How deeply can and should a given investigator go into phenomena underlying the TT process?
2. What theoretical or empirical points of view are relevant in developing and testing propositions and theories about TT?
3. What kinds of overall methodology are available and feasible?
4. What specific kinds of field techniques are effective?

In discussing the multitude of academic disciplines which have been applied to the study of TT, the author concludes:

> *It is no wonder that there is a babel of voices and viewpoints in the literature as well as an ever-increasing language or sets of special languages and concepts. We are still in the 'elephant-and-blind men' stage of this field, and it is too soon to say which specialties will make the significant contributions to our understanding of this complex phenomenon.*

Wells, J. G. and Waterman, R. H., Jr., "Space Technology: Pay-Off From Spin-Off," *Harvard Business Review*, July/August 1964, pp. 106-118.

This article is based in part on the studies of the University of Denver Research Institute sponsored by the National Aeronautics and Space Administration. NASA was one of the first federal agencies concerned with transferring their technology to the commercial sector. The problems and recommendations that resulted from their early efforts are brought out in this article, providing a good introductory perspective of the technology transfer process. Three primary questions are addressed by the authors:

- Is technology generated for our missile and space programs finding commercial application?
- What problems do companies experience when they attempt to put missile and space-related technology into commercial use? Are there solutions to these problems?
- What should be the role of government in stimulating the transfer of such technology to commercial use?

In the concluding remarks, it is stressed that barriers exist to secondary use of space-related technology. Critical for a company to overcome these barriers is management's ability:

1. to bridge the gap between space-related technological knowledge and commercial market requirements.
2. to identify individuals who can tap the formal and informal sources of spin-off ideas.
3. to provide an environment that motivates them to do so.

Aims, A., "Survey of Information Needs of Physicists and Chemists," *Journal of Documentation*, Vol. 21, No. 2, June 1965, pp. 83-112.

Results of the 1963 survey of 6,194 scientists (Chemistry & Physics), to determine which type of publications are used most commonly to (1) obtain current information in related fields, and (2) for information retrieval. For the whole sample, *abstracts* were regarded as the most important tool for finding information. Reviews were used by 90% of the sample, primarily for keeping up-to-date in the scientists specialty, and secondarily as a means of finding specific information. Original papers, though regarded highly as a source of information, were in need of improvement in their presentation to better clarify innovative content.

> *Although abstracts and original papers are considered the most important source of specific information, reviews, meetings, and conferences are the best vehicles for current awareness; the most interesting feature of the results here is the absence of any overwhelming agreement except on low use of patents and reports.*
>
> *Pure scientists are more dependent on the literature than industrial scientists and technologists, and that, in the UK at least, their "personal contact" system is much less developed. It seems that some of them, at least, might well benefit from a better network of personal contacts."*

Cole, R. and Gee, S. (ed.), *Proceedings of the Colloquium of Technology Transfer*, 5-7 September 1973, Washington, DC. Published by the Publications Division of the Naval Ordnance Laboratory, Silver Spring, MD, 89 pages.

More than eighty personnel involved with Federal Technology Transfer attended the "Colloquium." The impetus behind the meeting is explained in the Prologue given by the editors:

> *Technology transfer remains primarily a localized process heavily dependent on serendipity and the dispositions of the principles involved. Perhaps the source of the difficulty lies in the disparate nature of technology transfer, or in the frailities of the human being, or in the shortcoming of existing institutional policy. Nevertheless, the potential benefits from an effective technology transfer effort is widely acknowledged.*

Though the topics discussed at the Colloquium covered a broad range of ideas, of relative interest are the case studies presented by Howerton (pp. 25-28) and Tressel (pp. 29-32). Both deal with the problems of communicating new technology.

Howerton points out, "all disciplines are guilty of using their own argot, and seem to be unable to understand why others cannot fathom the 'obvious' values of their discoveries. Technology cannot be transferred if it cannot be communicated in understandable form."

Tressel, in discussing the basic problems of communicating new technology, states that innovative information must be directed to management level. But for these persons, "Their time is valuable, and the competition for attention is intense. They demand a concise, articulate presentation, and they respond to brevity, force, and attractive display."

Eames, R. D. and Starr, J., "Technical Publications and the User," *Human Factors*, 1965, 7(4), pp. 363-369.

In the paper, studies are cited which reveal numerous inadequacies in technical handbooks at the point of use. A concept of technical manuals and reports as devices to control behavior is explained. The need is put forth for a more empirical, rather than subjective, orientation to technical writing.

The author stresses:

> *From this more dynamic orientation to technical reports flows naturally an empirical (rather than subjective) answer to the question of which characteristics of technical reports effectively promote the desired behavior.*"

Though the primary topic of this paper is technical manuals, even reports of scientific experiments are shown to have an "implicit notion of direction."

Three opportunities for human factor's contributions to system-oriented publications are identified to occur during:

1. The Planning Phase, to aid in determining the quantity and type of publications required and the content and format that best fit the user's needs.

2. The Preparation Phase, to assure that human factors' information developed for other programs and for publications program is being applied.

3. The Equipment Evaluation Phase, when the efficacy of publications in the field is determined and revisions are made.

In addition, "Not to be overlooked is the necessity for applying 'human factors' data to the specifications and procedures that govern the preparation, content, and format of technical publications."

Federal Technology Transfer: Directory of Programs Resources Contact Points. Washington, DC: Federal Council for Science and Technology, Committee on Domestic Technology Transfer, 1975, 200 pages, (coordinated by Linsteadt, G. F.)

This report provides a tool for state and local government officials and private industry to more effectively share the results of federal programs aimed at the development of knowledge and technologies.

For each governmental agency, a "succinct description" is given of that agency's program including "its research base, technology transfer policy and objectives, areas of responsibility, methods of implementation, accomplishments, and user organizations."

This directory acts as an example of the methodology an organization employs to gain or generate benefits from documenting its efforts. In this case, the Federal Government is documenting its Technology Transfer programs.

Menzel, H., "The Information Needs of Current Scientific Research," *Library Quarterly*, Vol. 34, No. 1, January 1964, pp. 4-19.

Basic assumptions used over the past fifteen years toward improving science-information services are questioned. "Three fundamental facts" about information systems are discussed to illustrate the inadequacy of "reference services" at meeting "current awareness needs." These facts are:

1. Multiplicity of science-information functions;

2. The importance of informal and personal communication; and

3. The information needs of scientists are themselves a topic requiring investigation.

The integrated contributions of formal and informal factors in the linking model are seen as important. The author states that:

> *All the possible ways of classifying content cannot possibly be taken into account in the organization of journals, in the indexing and abstracting services, or even in the selection of titles of papers. Any given researcher must depend largely on friends who work in adjoining specialties, yet know what is of interest to him, to point out the pertinent material to him.*

DISTRIBUTION

Bottle, R. T., "A User's Assessment of Current Awareness Services," *Journal of Documentation*, Vol. 21, No. 3, 1965, pp. 177-189.

The author first describes how entries in journals concerning a scientific breakthrough experience an exponential growth as an increased number of scientists read and apply the discovery and write their own articles. He points out that until the literature has become commercially important enough for specialized journals, the literature is "very difficult to locate as one does not really know what to look for." Furthermore, "even though the epoch-making paper is picked up by abstracting services, the indexers may fail to realize its significance and no entries for it will appear under really significant headings."

Three classes of *current awareness* services are listed; those based on article titles, selective abstracts, and citation indexes. Reviews are rejected, though they can greatly increase attention given to important papers, because it is "too lengthy a process" to get current information to potential users.

The author raises a key question, however: "To whom are current awareness services addressed?" His answer: "Presumably they must be intended for the scientists of average or lesser ability, as it seems quite possible that the most productive scientists do not use them to any great extent and this does not affect their productivity."

Brown, L. A., "Diffusion Dynamics: A Review and Revision of the Quantitative Theory of the Spatial Diffusion of Innovation," (Doctoral Dissertation, Northwestern University) Ann Arbor, Michigan: University Microfilms, 1966, No. 66-13,958.

The focus is a quantitative expression of geographical theory concerning the spatial diffusion of innovations. The author introduces two additional variables into the existing models; the "market factor" and the "information factor." The "information factor" takes into account the effects of resistance to adoption, interpersonal communications, mass media communications information received indirectly from contact with manifestation of the innovation within the non-adopter's environment, and information received by contact with the innovation at the point of distribution.

From his work, the author concludes development planners and other agents of change should concentrate upon manipulating the distribution policy of the distributor of the innovation, since this is the only element of the system that can be manipulated and which has great control over the extent of diffusion that will occur.

Engle, J.F., Blackwell, R.D., Kegerreis, R.J., "How Information is Used to Adopt an Innovation." *Journal of Advertising Research*, Vol. 9, No. 4, 1969, pp. 3-8.

Three stages of information used by innovators are discussed. Mass media "played an important role in stimulating awareness and initial interest." Personal contact was sited as the most influential source in inducing innovative behavior. The study conducted used the patronage of a new automotive diagnostic center to identify "innovators." Rather than being impulsive, carefree consumers, "it appears that innovators may well be the most careful and systematic consumer group in the market."

Foster, R. N., "Organize for Technology Transfer," *Harvard Business Review*, November-December, 1971, pp. 31-37.

This article is subtitled, "A Market-Oriented Transfer Program to Exploit Existing Technology — Much of it Easily Traceable — is an Investment in the Future." A five-step process is given for an organization to acquire and apply innovative technological information. The author stresses the use of information services to find the technology that matches organizational needs. This step in the technology transfer process is described as:

"Systematically search the resource base in order to identify those approaches that are relevant to the problems involved." The author states that his experience has shown that when using computerized reference banks or public resource data banks, such as STAR, SIE, or NTIS, "a realistic expectation is one good idea for every 1,000 titles obtained from the initial investigation."

Once the information search has located the technology which matches the need or market opportunity, it is emphasized that the person who had the most to do with developing that technology must be located to help adopt it to the company's purposes. The author stresses that the ultimate objective of a reference bank search "is not to find a technology, but a technologist."

Knox, W. T., "Systems for Technological Information Transfer," *Science*, August 3, 1973, Vol. 81, No. 4098, pp. 415-419.

"The basic process in technological information transfer is coupling a problem and a solution."

"Coupling a problem and a solution must take place within human minds. It is a creative act."

The author discusses the attributes of the Federal Technological Information System in relation to the increased complexity and volume of information in the technological community. One of his basic premises is that, "a primary measure of the effectiveness of the technological information system is its capacity to allow people with problems to get in touch with people (or records) with potential solutions." Given an increase in volume of information, "for the usefulness of the systems to be constant, therefore, information condensers, transformers, and filters are required in proportion to the volume of information, number of users, and manner of system use."

A list is given of what the author considers the "most important changes" in the technological information system in the past 15 to 20 years. All relate directly to improving the distribution channel and better documenting information for user consumption. The changes he lists are:

1. The advent of the technical report as a major record form, supplementing books and journals.

2. Federal subsidy, by means of page charges, of journal publications.

3. Development of the computer, electronic display devices, and microforms.

4. The creation, mostly by federal agencies or with federal subsidy, of computer-based files of abstracts and indexes for specific subjects, with subsequent distribution to specific user groups.

Knox points out that though these changes have "vastly complicated the technological information system, they have also greatly improved its potential."

Licklider, J. C. R., "A Crux in Scientific and Technical Communications," *American Psychologist*, November, 1966, pp. 1,044-51.

A readable article, written by a researcher for the IBM Corporation, in which three alternative methods of transforming the "flood" of scientific information into applicable knowledge are discussed. The possible courses of action examined are:

1. Reduce the rate of publication.

2. Improve the arrangements for selecting pertinent documents.

3. Improve the arrangements for processing the information the documents contain.

The author quickly discounts the first possible course of action and discusses at length the counterproductivity and other

problems inherent with the second:

> *To provide a basis for discriminative document retrieval, deep analysis of published literature is required. At human processing speeds, deep interaction with information takes a long time. The supply of people able to understand science and technology well enough to contribute constructively to organization of its corpus for retrieval and dissemination is limited.*

Computer storage for the retrieval of information is argued to be the most effective solution to handling the increasing quantity of scientific documents. Though the author has an obvious bias, his discussion of the costs and benefits of computerized information system is excellent.

Overly, P. H. and Pince, B. W., "Maximizing Deliberate Use of Scientific and Technical Information," *Research and Development*, September 1966, 9, pp. 38-41.

This paper discusses an action program designed to "accelerate the deliberate transfer of scientific and technical information, principally that generated by federally sponsored scientific and technical programs, to the civilian community." An information system with the following functions is provided: Pre-Search Analysis, The Search, Post-Search Analysis, Document Transfer, and Utilization Follow-Up. In addition, a spectrum of specialized services are offered ranging from "a proprietary problem-solving approach to generalized current awareness programs." These services include: Retrospective Search, Monthly Updated Search or Current Awareness, Special Bibliographies and Indexes, Management Targeted Searches, and Liaison Activities. The authors state that,

> *This mix of services makes it possible for potential user systems to minimize their random use of information, thereby minimizing random changes.*

In conclusion, the belief is stated that:

> *Through the providing of information to potential user systems in a format which permits effective utilization, many of the problems which today hinder economics, social, and cultural progress can be resolved."*

ORGANIZATION

Allen, T.J., "The Differential Performance of Information Channels in the Transfer of Technology," Cambridge, MS, Alfred P. Sloan, School of Management, 1968, 628 pages.

The paper given in 1966 presents results of a comparative analysis of the information channels of parallel government R&D projects. Eight specific message channels were compared: literature, external sources, vendors, customers, technical staff, company research, analysis and experimentation, and personal experience. It was found that although channels external to the project group (customer agency and vendor) supplied three times as many suggestions of solution alternatives as do the lab's technical staff or other research programs, use of these channels are inversely related to the performance of the group at reaching solutions.

> *Comparing the sources of both solutions and rejected alternatives for higher and lower rated problems, shows a marked difference in the performance of channels, depending upon whether they originate within or outside of the laboratory organization. Those originating within the lab perform far better than those originating outside."*
>
> *The reason for this difference in channel performance is basically pinpointed as a problem of 'organizational boundary impedance.' This impedance occurs because 'the members of industrial and governmental organizations acquire through common experience, and organizational imposition, shared coding schemes which can be quite different from the schemes held by other members of their particular discipline.*

Baker, N., Siegman, J., and Rubenstein, A., "The Effect of Perceived Needs and Means on the Generation of Ideas for Industrial Research and Development Project," *IEEE Transactions on Engineering Management*, Vol. 14, No. 4, December 1967, pp. 156-163.

Report based on data collected on about 300 ideas created in a divisional laboratory of major U. S. corporations. Author argues that two primary elements for "idea generation" are:

1. Knowledge of a *need*, problem, or opportunity relevant to the company; and

2. Knowledge of a *means* or technique for satisfying the need.

His conclusion is:

> *Perception of organizational goals and needs and of time pressure and deadlines associated with current research work define the bounds of the researcher's freedom to select projects and change directions.*

Findings included that "knowledge of organizational problems, needs, and opportunities stimulate 75% of ideas. Furthermore, even when the idea was stimulated by something else, namely a means event, an organizational problem, need, or opportunity was sought and found before the idea was generated."

The effect of "time pressure" was to minimize the researchers (or technicians) opportunities for thinking by self and interaction, thereby reducing the likelihood of the researcher (or technician) to be exposed to or to recognize, stimulating need or means events.

The author concludes:

> *The creative environment within which the industrial researcher works is significantly influenced by the research management.*

Barth, R. T., "The Relationship of Intergroup Organizational Climate with Communication and Joint Decision-Making Between Task-Interdependent R&D Groups," (Doctoral Dissertation, Northwestern University), Ann Arbor, MI: University Microfilms, 1970, No. 71-10,087.

A particularly detailed and well documented dissertation which tests fifteen propositions concerning the effects of intergroup climate, on the level of *perceived* communication problems experienced by members of the group when dealing with each other. In each of the propositions, the level of task-interdependence perceived to exist between the groups was taken into account. Seven additional propositions tested dealt with: the relationship between perceived communication problems, the primary mode of joint decision-making used by groups, the quality of unity of effort achieved, and criteria used by managers when rating the effectiveness of participating groups.

Conclusions of testing 256 participants representing 60 working groups indicate a significant correlation between intergroup climate within an organization and perceived communication problems.

Churchill, G. A. and Ozanne, V. B., "Adoption and Diffusion Research: A Potential Tool for Improving Technology Transfer." Unpublished Conference Paper, 1967.

The basic thrust of this paper is,

> *Research into the adoption and diffusion of innovations provides a comprehensive set of terms and a conceptual framework well-suited to the study of technology transfer.*

A quite readable and relatively brief summarization of the works of major contributors to the field, including Katz, Mansfield, and Rogers, is given. A model of the industrial adoption process is developed, from which the conclusion is drawn:

The characteristics of the firm and of the decision-making group should account for variation in the dimensions of the industrial adoption process. Decision-making groups made up of the cosmopolitan, well-educated, and technically oriented members in profitable firms with rapid growth rates and good financial health may evidence a short adoption period and may employ a wide variety of information sources.

Essoglou, M.E., *Confrontation in the Lab?* (Young Scientists in Organizations) Unpublished paper, American University, Washington, DC, 1971.

A study to determine if Pelz and Andrew's findings (1966) on the "optimum organizational environment" are still valid. The author contends that "Young scientists and engineers espousing the *new ethic* will challenge R&D managements' wisdom in many ways and they will demand — through confrontation tactics perhaps — to participate in decisions affecting them, i.e., specifically their work . . ."

Though the authors' biases are quite evident, his conclusions and recommendation contribute to the adoption of a contemporary view of organization importance to the innovative process.

Considering trends away from ivory tower type environments for R&D and closer coupling of R&D to marketing, it seems that a loosely coordinated setting is best where the pressure of the work itself and the young researcher's needs for close personal contact bring about the levels of coordination most appropriate in each situation.

Schone, D.A., *Technology and Change: The New Heraclitus*, New York: Dell, 1967.

This book is an examination of the process and problems of technological innovation in the industrial corporation, within industries, and in American society as a whole. The *social* system of the corporation is shown to actively resist innovation.

The corporate society, like all societies, is in a state of dynamic conservatism. It strives for survival, stability, and continuity. It is active in its efforts to achieve its objectives and to maintain its society, structure, functions, values, language, and style of operation. 'Inertia' is wholly inadequate as a way of describing this dynamism

• • •

Schone advocates the necessity for systems view for technology transfer, where the government must play the central role. "Establishing a basis for government-industry trust is central to all those policies which might create a more favorable climate for innovation." The government's role would include:

- data collection,
- data interpretation to determine possible effects of alternate courses of action, and
- make decisions, set policies, and manage the process of innovation as it manages the economy.

PROJECT SELECTION

Brooks, H., "Applied Science and Technological Progress," *Science*, Vol. 156, June 30, 1967, pp. 1,706-1,712.

The concept of basic versus applied research is discussed. All research however, the author points out, "contributes or should contribute to the general objectives of the organization."

Research, and its subsequent use, is compared for government, universities, and private laboratories. For the R&D process in general: "Applied research is most effective when it is coupled to a 'market' that provides an automatic measure of effectiveness of the end product of research."

The author concludes by stating: "Good applied research is of little value if

the mechanisms do not exist to translate research results into goods, services, or operations."

Garner, W. R., "The Acquisition and Application of Knowledge: A Symbiotic Relation," *American Psychologist*, October 1972, pp. 569-574.

This paper starts with a discussion of the distinctions which scientists make concerning the research process, specifically between pure and applied research, general and specific research, experimentation versus observation, laboratory versus field research, and between analytic and wholistic research. The author then points out, "it is self-evident that the scientist doing *applied* research must maintain effective communication with the problem solvers, the people who apply the knowledge." Through the use of case examples, he attempts to additionally prove that, "it is just as valuable for scientists doing *basic* research to have communication with the people who have problems that need solution."

In summarization, the following remarks are made:

> *We all have, to a greater or lesser extent, accepted the premise that basic research should at least ultimately help solve real problems which exist in the society that supports the research. My point, however, is that the quality of the basic research is improved by communication between the basic research scientist and the people who have problems to solve. Thus, for scientists to engage in goal-oriented research, research aimed at solving problems already known to exist, is both to perform a service to society and to improve the quality of the basic research itself."*

Haglund, H.S., and Schlie, T.W., "Federal Incentives for Innovation: Preliminary Findings in the Development of an Experiment to Realistically Explore and Promote the Transfer of Technology From Federal Laboratories," Industrial Economics Division, Denver Research Institute, University of Denver, June 1975.

The object of the effort described in this report was to explore and examine how to improve the transfer of federal technology to the civilian/commercial sector, particularly with respect to the mission-oriented federal labs. The assumption was made that there exists useful technology in the federal labs to be transferred.

The authors' research indicated there is no "generalized single-factor barrier" that occurs between participants in a transfer. They propose, however, the following actions to improve a transfer of technology project:

1. establish early formal linkages between,
2. negotiate agreements or commitments of substance with, and
3. develop a technology transfer plan by all key participants in each specific transfer situation. The key participants being the federal laboratory, the potential user, and the appropriate manufacturer for a given product.

The authors observe that a frequent situation that can occur when there is not collaboration on a project by the key participants is that,

> *The laboratory will over or under innovate for what the user really requires and the manufacturer can feasibly produce — i.e., the technology will be too sophisticated (and, most likely, too expensive) for the job it is needed to perform or not sophisticated enough.*

Kogan, L.S., "The Utilization of Social Work Research," *Social Casework*. 1963, 44. pp. 569-574.

General observations presented upon the

use of research and the discussion of bridging the gap between research and utilization within this paper, provide a useful multi-variate overview of the barrier to technology transfer. Among his observations about research utilization, the author comments,

> *While these three purposes of research — understanding, action, and further research — are its major utilities, research is frequently used and sometimes misused to promote public relations and prestige, fund-raising, decision-postponing, and just plain busywork and featherbedding.*

Major reasons why research may not be utilized are listed in four categories. Within those categories appear the following statements:

> *It is commonly accepted that research has a better chance of being used if researchers, practitioners, and administrators have participated at every stage of the planning, execution, and interpretation of the research. This close and continuous interaction may prevent irrelevant issues and going off on methodological tangents.*

> *. . . both the potential user's motivation and capacity and his actual power to introduce program changes must be considered. Even the most obviously applicable research findings and implications may not affect a program if the potential user does not understand the 'message' of the research, if he is satisfied with status quo, if he is unable or unwilling to mobilize his energies and the available resources to introduce an innovation, or if his ability to introduce program changes is limited by his status and role.*

The organizational setting is also identified as potential barrier to research utilization.

> *Under setting, I would include not only the overall organizational structure of the agency, including the formal and informal lines of authority in program operation and planning, but also such factors as the priorities of different aspects of the program, the timeliness of introducing a modification in policy or practice, the cost of new as compared with established procedures, and so forth.*

URBAN TECHNOLOGY SYSTEM (UTS), Special Report submitted by Public Technology, Inc., January 16, 1976, under Contract NSF-C834.

The Urban Technology System (UTS) is a nationwide experiment to test methods of overcoming barriers to local government technological innovation. Sponsored by the National Science Foundation, the UTS assigned engineers and scientists called "Technology Agents" to 27 local governments, and provided them with technical support from major R&D organizations. The agents worked directly with their respective local government chief administrative officers and explored a wide range of local problems. In the first year of implementation, the UTS accounted for $6.4 million actual savings to local governments. The key to their success was the agents' ability to couple the local government needs with R&D facilities and the technical community. "UTS BRIEFS," a one-page documentation of effective innovations, were used to transfer technology at the "shirtsleeves" level.

An interesting and encouraging account of the potential benefits to be gained from properly managed technology transfer.

Utterback, J.M., "The Process of Innovation: A Study of the Origination and Development of Ideas for New Scientific Instruments," *IEEE Transactions on Engineering Management*, Vol. EM-18, No. 4, November 1971, pp. 124-131.

The process of technical innovation is treated as occurring in three phases: 1) idea

generation; 2) problem solving; and 3) implementation and development. Two questions are addressed in a study of the origination and development of 32 new scientific instruments:

> *First, what information led to the organization and development of new products by industrial organizations?*
>
> *Second, how did information contribute in the development of new products?*

The author states that,

> *Generation of an idea and its embodiment in a formal or informal proposal for commitment of resources requires the synthesis of knowledge of both a need and a feasible means to meet this need."*

For firms interested in stimulating the creation of ideas for new products, the findings of this study suggest the following:

> *First, integration of market and economic information with technical information and analysis and communicating needs and problems appear to be critical in generating ideas for new products.*
>
> *Secondly, while communication patterns and requirements vary considerably between the idea generation and problem-solving phases, technical consultation outside the firm appears to be important both in discovering needs and problems in obtaining and applying the most current technical information.*

CAPACITY OF RECEIVER

> Loy, J. W., "Social Psychological Characteristics of Innovators," *American Sociological Review*, February, 1969, pp. 73-82.

A study directed toward an extension and validation of Rogers (1962) findings on "innovativeness." Discriminating socio-psychological characteristics of innovators are isolated by means of personal interviews and questionnaires given to 106 English swim coaches.

Personal attributes which proved to assist in differentiating between adopter categories were, in order of significance, venturesomeness, professional status, imaginativeness, education status, dominance, sociability, and cosmopoliteness.

The author uses in his investigation "multiple discriminant function analysis to test whether multiple adopter categories can be differentiated." The results of the study showed a difference between the late majority "adopters" and "laggards" statistically significant at the .05 level when rounded to two decimal places.

> Presser, H. A., "Measuring Innovativeness Rather Than Adoption," *Rural Sociology*, December, 1969, No. 4; Vol. 34, pp. 510-527.

A descriptive study and discussion on the concepts of the innovator and innovativeness. The author's definitions are particularly precise and detailed, providing a usable framework for the readers on the topic of the early adoptor's role in the technology transfer process.

> *An innovation is something new and novel in human knowledge and experience. It has a point of origin in place and time. At its point of origin it must be an innovation, but is most commonly called an invention, a research result, or a new development of some older idea or ideas. In time, as knowledge and use of the innovation diffuse to people in the surrounding area the idea ceases to be an innovation in that area. It becomes a practice, then a common practice. While it is a common practice in one area, it may be an innovation in another. An idea is an innovation at different places at different times.*

This study somewhat parallels Rogers

(1958) by establishing behavioral categories for adoption of innovation. This author, however, strongly emphasizes the distinction between innovativeness and the adoption of new practices. His study shows that when identifying innovators, "the time of adoption or firstness notion is crucial."

Robertson, T. A., "An Analysis of Innovative Behavior and Its Determinants," (Doctoral Dissertation: Northwestern University) Ann Arbor, MI: University Microfilms, 1970, No. 67-4263.

A marketing study of innovative behavior, where the innovator is typed as an early purchaser of a new product (the touch tone telephone in this study). It is hypothesized that innovative behavior is a function of A) *Predispositioned factors* on the part of the individual, and B) *Exposure and response* to the communications flow regarding innovation. The predispositioned factors form the predictive part of the model presented, while the communications flow is looked upon as an ongoing, necessary requirement to any innovative behavior. The predispositional facts used as variables to predict innovative behavior are: venturesomeness, social integration, cosmopoliteness, social mobility, privilegedness, interest polymorphism, and personality. Communication flow is defined as consisting of the following channels: Mass media, personal contact, change agent, and impersonal contact.

Rogers, E.M., "Categorizing the Adopters of Agricultural Practices," *Rural Sociology*, September 1958, Vol. 23, pp. 345-359.

Data for this report, taken from a 1955 study of 148 Iowa farm operators and from a 1957 study of 104 Ohio farmers, showed that the adoption distributions over time are bell-shaped and approach normality.

> *. . . the adoption of a single practice over time will approach a normal distribution. The distribution of scores on an adoption scale, composed of the adoption of a number of new practices, will also approach normality. The normality of these adoption scores facilitates the categorization of individuals into the five adopter categories of innovators, early adopters, early majority, late majority, and laggard.*

The author uses standard deviations away from the mean to divide adopter in categories, but he points out, "The five categories used in the present case are an arbitrary number." They are, however, "exhaustive, mutually exclusive, and are derived from one classificatory principle (time of adoption)."

Rogers, E. M. with Shoemaker, F. F., *Communicator of Innovations: A Cross-Cultural Approach*, (New York: Free Press of Glenco, 1971).

More than 1,500 publications on information diffusion were reviewed to derive generalizations to facilitate understanding of the technology transfer process. The work is primarily addressed to "change agents" and social scientists to provide linkages with more general social science theory. Findings and conclusions reached delineate a multitude of factors involved in the communication of innovative ideas. Of particular interest, Chapter 5 discusses categories for the rate of innovation adoption by organizational members. The trait of innovativeness is conceptualized as a bell-shaped curve, and adaptor categories are established by deviation from the mean performance of the group. The traits of the 2.5% identified as innovators, or early adopters are discussed in detail. In addition, methods for predicting innovativeness, and their relative success are explored.

Rogers, E. M., "Characteristics of Agricultural Innovators and Other Adopter Categories," Wooster, OH: *Agricultural Experiment Station Research Bulletin*, 882, 1961, 97 pages.

Data for this study was obtained from a random sample of 104 Ohio farmers and from a state-wide sample of 99 innovators. The author suggests it is "important to know the characteristics of agricultural innovators and other adopter categories. Then, certain target audiences might be selected and particular communication methods chooses to reach them." Innovativeness is defined as "the degree to which an individual is relatively earlier to adopt new ideas than the other members of his social system."

The major findings were:

> *Innovativeness was found to be negatively related to age and positively related to social status, years of education, size of farm, gross farm income, degree of farm specialization, communication with county agents, and opinion leadership.*"

LINKER ROLE

Allen, T. J., "Communication Networks in R&D Laboratories," *R&D Management*, Vol. 1, 1970, pp. 14-21.

This paper is a restatement and continuation of the earlier work of Allen (1966, 1969). Among the questions addressed is: *How does information enter the organization?* Analysis showed both outside personal contact and use of the literature were not very instrumental as a means of transferring information into the organization. The process by which an organization most effectively imported information was discovered to be an indirect one. A small number of key people, called the "technological gatekeepers," were found to be the key individuals upon whom others relied very heavily for information. The gatekeepers differed from their colleagues in their orientation toward outside sources.

> *They read far more, particularly the 'harder' literature. Their readership of professional engineering and scientific journals is significantly greater than that of the average technologist. They also maintain broader-ranging and longer-term relationships with technologists outside of their organizations. The technological gatekeeper mediates between his organizational colleagues and the world outside, and he effectively couples the organization to scientific and technological activity in the world at large.*

The geographical location of key organizational structure, and architectural design of the physical facilities are all discussed as important variables in insuring important informal relationships and an effective communication network.

Creighton, J. W., Jolly, J. A., and Denning, S. A., "Enhancement of Research and Development Output Utilization Efficiencies; Linker Concept Methodology in the Technology Transfer Process," Naval Postgraduate School, NPS-55CF72061A, 1972, Monterey, CA.

This study defines the linker as operating within the organization which receives, or requires, technological knowledge. The hypothesis is formulated that individuals functioning as linkers would exhibit similar identifying traits and characteristics as those of the gatekeeper, opinion leader, innovator, and early knower of an innovation. A questionnaire entitled, "Professional Preference Census" is developed to identify individuals possessing linker characteristics. When administered to 1726 naval officers within the Civil Engineering Corps (65% response rate), the PPC proved "very effective" in identifying those persons performing as "linkers" and those persons performing as "stabilizers."

The "linker" is only one of the determinants in the "Predictive Model of Technology Transfer" as presented in this study.

The model is evolved about the fact that "a program of technology transfer must include a mechanism which effectively links or couples the source of knowledge with the eventual utilization of knowledge." They choose to place this linking mechanism, as delineated by their Predictive Model, in the users' organization because of behavioral and economic considerations. The hypothesis is made that "given equal resources, an effective transfer mechanism in the user organization will produce a higher coefficient of technology utilization than an intermediary, third organization placed between supplier and user."

Czepiel, J.A., "Word-of-Mouth Processes in the Diffusion of a Major Technological Innovation," *Journal of Marketing Research*, Vol. II, May 1974, pp. 172-180.

A microanalytical study of the diffusion of a major technological innovation among 32 private industrial business firms. The most significant finding was the discovery of a "functioning informal community linking together the firms." Results further indicated:

> *The active use of friendship relationships in information-seeking concerning the innovation not only reinforces the societal findings but makes real the concept of diffusion as a social process in the industry.*

One of the hypotheses tested in the study stated that early adopters would exhibit greater opinion leadership with respect to innovation. The data collected supported this hypothesis. Respondents to a questionnaire indicated, in fact, that except for a few instances,

> *all information-seeking concerning the innovation was directed to earlier adopters.*

Farr, R. S., "Knowledge Linkers and the Flow of Education Information," Institute for Communication Research, Stanford University, September 1969.

One of the most direct discussions about linkers, their characteristics, and linking institutions. The author incorporates the works of Rogers, Havelock, Lazarfeld, and others into the framework of his paper. The need for a "linker" is clearly stated, and the primary tool of the linker is identified as "informal, interpersonal channels of communication."

> . . . *word gets around best when people talk to each other. It is this interpersonal network of communication, therefore, that the linker must seek to activate.*

Advantages of permanent linking institutions are identified as security, identity, coordination, and specialization. The importance of organizational "gatekeepers" in the channels of communication in the adoption process is amplified,

> . . . *the gatekeeper functions very much like a second linker in the flow of information systems. He actively seeks out information and then makes it available to the rest of the audience.*

> *In sum, gatekeepers provide access to our target audience and its channels of interpersonal communication, while at the same time they are more easily accessible to us via the mass media and more likely to be receptive to the new ideas we have to present.*

Havelock, R. G., *et al, Planning for Innovation Through Dssemination & Utilization of Knowledge*, Ann Arbor, MI, ISR, University of Michigan, 1971.

The author presents a "typology of linking roles." The nine pure type linking agents he discusses are from a "wide spectrum of sources across many fields of knowledge and grouped under major headings which suggest their most salient function or the assumptions about the transfer process which each set seems to imply." The nine type linking roles he envisions (for each of which he presents the function, field, examples, and sample references) are: conveyor, consultant (charge agent), trainer, leader, innovator, defender, knowledge-builders as linkers, practitioner as linker, and the user as linker.

Central emphasis is placed on the "leader" for successful TT. The three types of leaders discussed are: the formal leader (administrators), the gatekeeper (the individual who is in the strategic position to control input into the organization), and the *opinion leader*. The opinion leader (the informal social leader of relevant reference groups) is instrumental in the legitimization of new ideas and practices.

The innovators or early adopters are discussed as demonstrators and quasi-opinion leaders *for the real opinion leader*. It is argued that the innovator and opinion leader must be complementary agents in the TT process, but the author leaves questions as to how this type of relationship is formed.

> *The importance of applied researchers as linkers is related in part to the inadequacy of the conveyor concept. The fact is that few conveyor-type linkers are capable of retrieving knowledge from basic research, screening, and packing it, and at the same time transmitting it to the user.*

The point is stressed that the successful researcher is a true linker who can translate usable services and products.

The user, in order to be his own linker, must acquire:

> *Knowledge of resources, access to resources, and diagnosis of his own needs."*

Havelock rejects the hypothesis that the typical knowledge user has these three things and thereby, reaches the general conclusion that —

> *For the foreseeable future, all fields of knowledge will require the installation and support of a variety of linking roles if effective utilization of research is to be realized.*

Holland, W.E., "Characteristics of Individuals with High Information Potential in Government Research and Development Organizations," *IEEE Transactions on Engineering Management*, Vol. 19, No. 2, May 1972, pp. 38-44.

This study was designed to identify focal individuals within informal communications networks. To identify these special individuals who seem to be "a node in the internal communication network," organizational members were rated by their colleagues on their information potential (IP) or perceived information-source value. Results of the study indicated that the individual with high IP ratings used more and different sources of technical information, was seen to associate seemingly unrelated ideas, was as approachable as the other members of his organization, and was perceived as a credible source of information.

In conclusion, the author emphasizes that managers must be in the position to affect the efficiency of the informal

communication of technical information within their organizations.

Although the manager can never hope to completely control informal transactions, his best hope for positively influencing informal networks lies in the identification and motivation of the special communicators in his organization.

Katz, E., "The Two-Step Flow of Communications: An Up-to-Date Report on Hypothesis, *Public Opinion Quarterly*, Vol. 21, 1957, pp. 61-78.

A refinement and elaboration of Lazarfeld's (1948) hypothesis of the "two-step flow of communications." The author evaluates three studies that were designed primarily to single out and determine the traits of "opinion leaders," the importance of personal influence, and sociometric influence on communication networks. In general, the author concludes:

Opinion leaders and the people who they influence are very much alike and typically belong to the same primary groups of family, friends, and coworkers.

. . . It is the opinion leader's function to bring the group in touch with this relevant part of its environment through whatever media are appropriate. In every case, influentials have been found to be more exposed to these points of contact with the outside world. Nevertheless, it is also true that, despite their greater exposure to the media, most opinion leaders are primarily affected not by the communication media but by still other people.

Lewin, Kurt, "Forces Behind Food Habits and Methods of Change," in Report of the Committee on Food Habits, *The Problem of Changing Food Habits*, Washington, DC: National Research Council, National Academy of Science, 1943.

A well presented study that can be viewed as an interesting analogous between the determinates of technology transfer and "why people eat what they eat." The author's discussion about the importance of "gatekeepers" in determining the food that will enter the home is particularly relevant. "Food does not move by its own impetus. Entering or not entering a channel and moving from one section of a channel to another is effected by a gatekeeper."

To understand and influence food habits we have to know in addition to the objective food channels and objective availability, the psychological factors influencing the person who controls the channels.

Results, methodology, and underlying rationale of experiments to change "food habits" are presented. A group setting with "democratic discussion leading to a decision" was found most conducive for change. "The group setting gives the incentive for the decision and facilitates and reinforces it.

Rogers, E. M. and Jain, N. C., "Research Utilization: Bridging the Communications Gap Between Science and Practice." Paper presented at the Joint Session of the Information Systems Division of the International Communications Division of the International Communications Association and the Behavioral Science Interest Group of the Speech Association of America, New York, December 1969.

A carefully written paper designed to synthesize research done on both organiza-

tional research utilization and knowledge or innovation diffusion (intra *vs* intersystematic communication flows). The authors contend there exists three social systems in the research utilization process, these being: 1) the *Research System* whose function is to create and develop innovations, 2) the *Linking System* which communicates client needs to researchers and diffuses innovations to clients, and 3) the *Client System* which must recognize needs for research and adopt innovations. A series of hypothesized propositions dealing with communications between these three systems are presented. Some of the concepts discussed in the propositions include the need for two-way communications, the effect of homophily versus heterophily on communication variables, empathy as a facilitator of information linkage, and the importance of opinion leaders to the linking system.

CREDIBILITY OF SOURCE AND CHANNEL

Aronson, E., Turner, J., and Carlsmith, J., "Communicator Creditability and Communication Discrepancy as Determinants of Opinion Change," *Journal of Abnormal and Social Psychology*, 1963, Vol. 67, No. 1, pp. 31-36.

An application of cognitive dissonance theory is used that suggests "opinion change is a function of a specific complex interaction between the creditability of the communicator and the discrepancy of the communication from the initial attitude of the recipient." The authors suggest that the apparently inconsistent findings of Hovland, *et al*, (1952) could be explained by "an interaction between discrepancy and creditability."

The results of the authors study show:

It is apparent that the highly credible communicator was more successful in inducing opinion change than the mildly creditable communicator at every point of discrepancy. Moreover, in the highly credibility condition, opinion change increase with degree of discrepancy. The mildly credible communicator is not only less able to induce opinion change, but actually induces less change with a large discrepancy than with a moderate discrepancy.

Berlo, R.K., Lemert, J.B., and Mertz, R.J., "Dimensions for Evaluating the Acceptability of Message Source," *Public Opinion Quarterly*, 1969, 33, pp. 563-675.

The research reported here extends the work of Hovland and his colleagues on source credibility by investigating the criteria actually used by receivers in evaluating message sources. Three dimensions are isolated: Safety, Qualification, and Dynamism. The authors argue that source image should be defined in terms of the perception of the receiver; not in terms of objective characteristics of the source.

The three meaningful and statistically independent dimensions of source credibility resulted from two separate factor analytic studies. The following scales are suggested as most representative of these dimensions:

Safety:
safe-unsafe; just-unjust; kind-cruel; friendly-unfriendly; honest-dishonest.

Qualification:
trained-untrained; experienced-inexperienced; skilled-unskilled; qualified-unqualified; informed-uninformed.

Dynamism:
aggressive-meek; emphatic-hesitant; bold-timid; active-passive; energetic-tired.

In summary, the authors point out,

The factor analytic studies provide an operational base for defining source 'image.' They provide a base for tying the notion of these source evaluations to various processes of social influence, and various typologies of communication receivers. They also indicate a need to determine the relative contribution of the three dimensions to persuasion.

Griffin, K., "The Contribution of Studies of Source Creditability to a Theory of Interpersonal Trust in the Communication Process," *Psychological Bulletin*, 1967, Vol. 68, No. 2, pp. 104-120.

Interpersonal trust in the communication process is defined as reliance upon the communication of another person in order to achieve a desired but uncertain objective in a risky situation. A theory of the dimensions of interpersonal trust in communication is presented in this study. A detailed review of related literature on this topic is also given, plus an excellent list of references is provided at the end of the paper.

The following five characteristics as perceived by a listener are concluded to be the dimensions of a communicator's ethos (image):

1. *Expertness* relevant to the topic under discussion; this expertise may be in the form of quantity of pertinent information, degree of ability or skill, or validity of judgment.
2. *Reliability* as an information source; this reliability may be perceived as dependability, predicability, or consistency.
3. *Intentions* toward the listener, perceived by him as favorable or unfavorable.
4. *Dynamism* of the speaker as perceived by the listener, that is, communication behavior which appears to be more active than passive.
5. *Personal attraction* of the speaker for the listener, a dimension difficult to measure, possibly operating without conscious perception by the listener and without his knowledge of its interaction with one or more of the four factors listed above.

In addition to these five characteristics of the speaker which may be perceived directly by the listener, a sixth variable is discussed that influences the listener's perception of a speaker, that is the "majority opinion of other listeners regarding the degree of trust that should be placed in the communicator."

Hovland, C.E. and Weis, W., "The Influence of Source Creditability on Communication Effectiveness," *Public Opinion Quarterly*, Winter, 1951-52, pp. 634-650.

A study conducted to determine what part the attitude of the audience toward the communicator of a message has upon the effectiveness of the communication. Among the interesting conclusions drawn were:

The immediate reaction to the 'fairness' of the presentation and the justifiability of the conclusion drawn

by the communication is significantly affected by both the subject's initial position on the issue and by his evaluation of the trustworthiness of the source.

But, *No difference was found in the amount of factual information learned from the 'high creditability' and 'low creditability' sources, and none in the amount retained over a four-week period.*

And, *There was a DECREASE after a time interval in the extent to which subjects agreed with the position advocated by the communication when the material was presented by trustworthy sources, but an INCREASE when it was presented by untrustworthy sources.*

Kiesler, C. A., Pallak, M. S., III, and Archer, R., "Commitment of Audience, and Legitimacy and Attitudinal Stance of Communicator: A Test of the 'Woodwork' Hypothesis," *Psychological Reports*, 1974, 35, pp. 1035-1048.

A laboratory experiment was conducted in which the following factors were varied: one's prior commitment to consonant behavior and the legitimacy and attitudinal stance (agree-disagree) of a communicator. A variety of measures were taken to define subject's perceptions of legitimate and illegitimate communicators. Legitimacy tended not to affect uncommitted subjects. Committed subjects responded positively to the legitimate communicator and negatively (boomerang) to the illegitimate speaker, regarding attitude change, behavioral measures, and information-seeking, regardless of the attitudinal stance of the communicator.

The authors also found,

The legitimate communicator was perceived to be more knowledgeable, more qualified, more persuasive, and more competent than the illegitimate communicator.

They conclude that,

The power of the legitimacy manipulation is noteworthy. This manipulation affected subject's perceptions of the speaker not only in areas relating specifically to expertise, but also the speaker's justification in speaking out.

Zimbardo, P. G., Weisenberg, M., Forestone, L, and Levy, B., "Communicator Effectiveness in Producing Public Conformity and Private Attitude Change," *Journal of Personality*, 1965, 33, pp. 233-255.

Communicator characteristics which were objectively unimportant to the topic of communication were studied in their relationship to behavioral compliance and to subsequent attitude change. These objectively irrelevant aspects of communicator credibility were hypothesized as being of great importance in interpersonal communication situations in which "attitude change is often mediated by a host of physical, social, and psychological traits of the influencing agent."

The positive communicator, as determined by questionnaire, was rated high on being calm, courteous, mature, clear-thinking, and neither tactless nor hostile to others. He was, however, seen as affectively neutral, being neither cold nor warm. The negative communicator, by comparison, was seen as no different in possessing those traits necessary to effectively execute the task, but was characterized as not a warm person, being primarily bossy, tactless, demanding, snobbish, not genuinely interested in the subjects, egotistical, and

somewhat insincere and not very calm.

The results of the study indicate that:

> . . . *a communicator who advocates public compliance to behavior discrepant from a person's attitudes and values can also influence attitude change, without specifically communicating persuasive arguments and conclusions. Those who accept the inducement change in the desired direction, while those who do not comply often show boomerang effects — adopting more extreme attitude positions. This attitude change following public compliance (predicted by the theory of cognitive dissonance) is greater when behavior cannot be as readily justified in terms of communicator characteristics, i.e., when the communicator is negative rather than positive. Thus, source factors which are on an irrelevant dimension of communicator credibility may operate in interesting and nonobvious ways.*

REWARD SYSTEM

Deci, E. L. "Effects of Externally Mediated Rewards on Intrinsic Motivation," *Journal of Personality and Social Psychology*, 1971, Vol. 18, No. 1, 105-115.

Two laboratory experiments and one field experiment were conducted to investigate the effects of external rewards on intrinsic motivation to perform an activity. A review of the literature relevant to this area of research is given first. This study is an extension of that earlier research, in that a new theoretical framework is developed which employs a cognitive approach and concentrates on that nature of the external reward. The results of the experiments indicated that (a) when money was used as an external reward, intrinsic motivation tended to decrease, whereas (b) when verbal reinforcement and positive feedback were used, intrinsic motivation tended to increase.

> *It appears that money — perhaps because of its connotation and use in our culture — may act as a stimulus which leads subjects to a cognitive reevaluation of the activity from one which is intrinsically motivated to one which is motivated primarily by the expectation of financial rewards. In short, money may work to 'buy off' one's intrinsic motivation for an activity.*

Lingwood, D. A. and Morris, W. C., *Research into Use: A Study of the Forest Service Research Branch*, CRUSK, University of Michigan, Ann Arbor, MI, March 1976, 290 pages.

A "comprehensive action-research project" covering the following areas:

a) Organizational planning and goal-setting

b) Individual satisfaction, information-processing, and other factors

c) Organizational climate, leadership, and functioning

d) Production and dissemination of outputs for scientific clients and for applied clients

On the subject of rewards, the authors comment:

> *Obviously, rewards are the glue which holds organizations together and provides the response to individual needs for recognition of accomplishment.*

For research Project Leaders, the study

conducted discovered that high contributions to applied versus pure scientific research actually appeared to reduce the chances for their promotion. The basic thrust of the data collected indicated:

> *No researcher is going to get very involved in application work if he does not see a predefined and operating system of rewards for such work.*

The impact of organizational conditions in providing a good research environment is underlined in the study. In looking at who was most satisfied with their job and organization, the authors found that:

> *The amount of challenge and dedication to work the researcher sees, good informal communication within the station, and feelings of good opportunities for career growth are the most important predictors of satisfaction.*

Maier, N. R. and Hoffman, L. R., "Financial Incentives and Group Decision in Motivating Change," *The Journal of Social Psychology*, 1964, 64, pp. 369-378.

An experiment conducted to test the effects of different incentives upon worker's willingness to accept a new work method. 149 groups of undergraduate students participated in the experiment where problem-solving was done by simulating a work situation through the use of a role-playing format. Some interesting findings resulted from the study indicating that financial reward may not be in many cases the proper incentive in problem-solving situations.

> *Problem-solving, moreover, is a satisfying activity for most people, regardless of the method of pay. Men will solve the problem of how to use certain information to improve their work pattern if they do not feel threatened with a loss of job security or job satisfaction. Reward is only necessary if men are asked to accept a solution that they fear deprives them of something.*

As a result of the experiment, it was hypothesized that —

> *In discussions between foreman and workers, when the foreman uses a problem-solving approach in which his and the member's problems are solved jointly, he is more likely to obtain solutions of high quality and acceptance than when he applies extrinsic incentives to persuade the members to adopt his point of view.*

Mock, J. E., "Barriers and Stimulants to the Transfer of Public Technology," in *Technology Transfer*, Proceedings of the NATO Advanced Study Institute on Technology Transfer, June 24-July 6, 1973, Ed. H.F. Davidson *et al*, Leiben, The Netherlands, Nordoff International Publishing, 1974, pp. 301-310.

An interesting commentary on the problems associated with the transfer of technology to local and state governments. The author lists twenty-six barriers to innovation in the public sector and five specific solutions to these barriers in the form of "innovation stimulants." He aims his solution at the following significant barriers:

1. Lack of venture funds.
2. Lack of technically sophisticated people.

3. Lack of continuing dialogue between government and R&D people.

4. Highly fragmented nature of the domestic market.

5. High inertia on the part of state and local government.

Under the fifth point, the following comment is made:

> . . . *most government employees and public officials are characterized by resistance to taking large risks because of the nature of the incentive/reward/punishment system in government and the relatively short planning horizon of the elected officials at the state and local level.*

Along this same vein, the author discusses the following barrier to Technology Transfer:

> *There is an unbelievable inertia to our complex social system . . . The important point is to realize that beliefs, values, and attitudes change slowly — and for some people, never. The public official can seldom be too far in 'front' of the views held by his constituents — else he will not be a public official for long.*

Nyenhuis, K. and Welborn, J., *Analysis of the Perceived Reward to the Receiver and Its Impact on the Predictive model of Technology Transfer.* Master's Thesis at the Naval Postgraduate in Monterey, CA, June 1976.

This study was an attempt to validate "perceived reward" as one of the factors in the technology transfer process as proposed by Creighton, Jolly, and Denning (1972) in their "Theoretical Predictive Model." The authors center their study on "the behavioral influences of the perceived reward to that individual called the receiver who initiates or conceives an idea in an organization and the factors which impact on this receiver to ultimately determine whether technology will be transferred."

Results of the study showed that intrinsic, rather than extrinsic, rewards had "much more strength and impact in motivating certain individuals." Moreover, they indicated the importance of organization type in determining perceived rewards:

> *Whether the organization is growing or contracting, coupled with the personality of managers which are often reflected in their employees and the implementation and utilization of certain reward structures has a great impact on idea flow. How the above factors are perceived by the receiver in a particular organization will determine in large measure his willingness to initiate idea transmission.*

The methodology of Jolly and Creighton (1974) used to identify individuals with "linker" characteristics was applied to the subjects of this study. A "significant dependent relationship" was found between the distribution of responses on the reward model variable and the linker behavior score. This led the authors to the generalization that there are interrelationships between all nine factors of the "Theoretical Predictive Model" of Jolly and Creighton.

Peters, E. B., "Are We Giving Away Our Science and Technology?, *The Journal of Business Communication*, Vol. 12, No. 2, Winter 1975.

An interesting paper and a unique prob-

lematic application of the informal factors involved in the technology transfer process. The importance of scientific meetings is situated both as a reward mechanism and information exchange activity.

> . . . *recognition by colleagues is the reward which is looked upon as the most appropriate and legitimate, for it validates the requirements of the scientist's role. In Addition, many consider the need to create a basic human need, but the act of creation requires a competent response to be complete.*

The instrumental part played by the "technological gatekeeper" is developed in this study.

> *These important individuals seem to take up their activities spontaneously and are capable of bridging the communication's gap and bringing knowledge for the external environment into the closed internal environment of the organization.*

In summary, the author states:

> *According to the sociology of science, the researcher presents papers to gain the esteem of his fellows for psychic reward and for prestige.*

The research described here suggests that there are more eminently practical and tangible benefits as well; for there are immediate concrete rewards of relevant information.

WILLINGNESS

Berlin, L.N., "Resistance to Change in Mental Health Professionals," *American Journal of Orthopsychiatry*, 39 (1), January 1969, pp. 109-115.

Although the author focuses upon barriers to change in the mental health profession, his insights are quite relevant and transferable to other vocations. This paper, based on personal experience, was given at a 1968 meeting of the American Orthopsychiatry Association. The author comments that:

> *In the education, engineering, medicine, and mental health professions, resistance to change sometime takes the form of acknowledging the relevance of new ideas and methods but not accepting them in practice or trying them out fully in new training and practice areas.*

In summary, the point is made that individuals resist change because —

> *such change may reduce their status, financial return, sense of personal satisfaction, and feelings of competency. Learning new methods . . . , are threatening to our established and already learned theoretical frameworks and practices.*

Cetron, M. J., "Technology Transfer: Where We Stand Today," in *Technology Transfer*, Proceedings of the NATO Advanced Study Institute on Technology Transfer, June 24 - July 6, 1973, Ed. H. F. Davidson *et al*, Leiben, The Netherlands, Nordoff International Publishing, 1974, pp. 3-28.

This article is the chairman's introduction to the above cited conference. The author surveys the "state of the art" in international technology transfer. An excellent overview of the multitude of variables in the transfer process is provided. Of particular interest is the discussion of the characteristic barriers and stimuli to innovation. The types of barriers listed fall under the

following categories: Laboratory, Developer/Producer, Marketing/Distributional Channel, State Government User, Federal Government, Public, State Barriers to Local Governments, and Local User Barriers. Stimuli for innovation are listed under the categories of Behavioral, Economic, and Legal. The author states:

> *It is important to remember that technology transfer not only means transferring knowledge but also refers to the application of that knowledge, which includes technological development, application, marketing, and management of that technology. Barriers and stimuli to this innovative process may arise at any point in the sequence.*

Gallup, George, "The Absorption Rate of Ideas," *Public Opinion Quarterly*, Fall, 1955, pp. 232-242.

This article is based on the author's presidential address given before the 1955 meeting of the American Association for Public Opinion Research. Dr. Gallup relates some ideas on public opinion sampling, education, and political science to his absorption rate concept. Some of the variables in his concept correlate directly to the predisposition of the message receiver and the perceived creditability of message sender:

> *Persons with vested interests, if there be any, will see to it that mental road blocks are put in front of every new idea which deprives them of prestige or power...*
>
> *The character of the group most closely concerned or identified with the idea will be an important factor in determining how fast it gets into the blood stream.*
>
> *Probably most important is the complexity of the idea. If it is abstract, it faces a real struggle against mental limitations and mental inertia.*

Pearson, A.W. and Richards, T., "Current Problems in Transferring Science to Technology," in *Technology Transfer*, Proceedings of the NATO Advanced Study Institute on Technology Transfer, June24-July 6, 1973, Ed. H. G. Davidson, *et al*, Leiben, The Netherlands, Nordoff International Publishing, 1974, pp. 67-76.

Two problems that pose as barriers to the successful utilization of science and technology are discussed. The first of these is the "not-invented-here-syndrome." The authors point out that many new and potentially profitable ideas have been rejected by scientists and technologists because they interpret them as "a threat to their own reputation."

A more serious and contempory barrier to technology transfer is seen to be the inability of potential technology users to understand the language of and communicate with the research community. Conversely, the inability of scientists and technologists to put their information into a language which the potential user can understand is stated as a problem. The consequences of these problems is the main subject of the present study. The authors are concerned about getting productive results from meetings where the research and potential user groups gather to exchange information. Too frequently, the author points out,

> *Attempts to invite such people to discussions on topics which appear relevant to all parties often lead to a polarization, with each group definding its own interests and/or omitting to*

listen to any of the points raised by the other.

Schon, D. A., "Champions for Radical New Inventions," *Harvard Business Review*, Vol. 41, No. 2, March/April 1963, pp. 77-86.

The author addresses this study to four basic questions dealing with change and innovation in large organizations. These questions are:

- *Why do small companies, large corporations, military laboratory employees, and independent inventors find it so difficult to sell really new inventions to the military service?*
- *What is the nature of resistance to innovation in military and business organizations?*
- *What does experience show to be the requirements of successful technical innovation?*
- *What steps can management take to ensure that the necessary development work will go into promising proposals for radical new products and processes?*

In this well thought out and interestingly presented paper, the author examines resistance to change from several angles. He uses the military service as the subject of his study, pointing out that it is an "enormous and only slightly distorted mirror in which patterns surrounding technical innovation stand out clearly."

In quoting Elting Morrison (1950), the author points out that opposition to change is normal in both military and civilian organizations.

It is wrong to assume, as civilians frequently do, that this blind reaction to technological change springs exclusively from some causeless Bourbon distemper that invades the military mind. There is a sounder and more attractive base. The opposition, where it occurs, of the soldier and the sailor to such change springs from the normal human instinct to protect oneself and more especially one's way of life.

This article concludes with the statement that:

A willingness to face the price of innovation is a major part of the problem of technological progress.

Wright, P., "Technology Transfer and Utilization: Active Promotion or Passive Dissemination," *Research/Development*, September 1966, 9, pp. 34-37.

This paper is an examination of some of the factors that impede or facilitate the transfer of NASA technology. A two-phase program was established. The first phase was characterized by active promotion of the merit of selected portion of the NASA technology; the second phase was an effort to trace the outcome of self-generated organizational interest in the technology.

In attempts to introduce new technology into an organization, the author stipulates:

Willingness to take advantage of new technology might be greatest when the disturbance was smallest (to the industrial productive equilibrium) and least when the disturbance was greatest.

Despite efforts to catalyze and expe-

dite commercial utilization of NASA technology, only 0.15 per cent of the postulated situation, and 5-1/2 per cent of non-negative situations after determination of initial relevance, ultimately put the technology to use. One major cause of this was associated with the level to which the technology had been developed for commercial use. Specific reasons for passivity and negativeness encountered in the study were cited as indeterminate and uncertain applicability of the technology, disseminated information only retained as reference material, and uncertain market potential.

In summary, the results of this study showed:

> *Almost eight times as much interest was motivated by the possibility of improving an existing product or process as was motivated by the chance of acquiring a completely new addition to use the inquirer's processes and products. Most self-generated interest was the context of minimum disturbance to the industrial equilibrium.*

CROSS REFERENCE GUIDE

Though articles in the bibliography are categorized by factors in the model to which they pertain, some articles and reports have a clear multiple applicability. This cross reference guide is intended to aid the reader in locating the material included in the bibliography which is deemed especially relevant to each factor in the model. Articles and reports already listed under the proper category in the body of the bibliography are not relisted here. For those listed as pertinent to the indicated category, the author's name, date of the work, and category under which they are placed in the bibliography are given.

DOCUMENTATION

Knox, 1973: *DIST*
Bottle, 1965: *DIST*
Brooks, 1967: *PROJ*
Overly, 1966: *DIST*
UTS, 1976: *PROJ*

ORGANIZATION

Allen, 1970: *LINK*
Lingwood, 1976: *REWA*
Kogan, 1963: *PROJ*
Schon, 1963: *WILL*

CAPACITY

Engel, 1969: *DIST*
Churchill, 1967: *ORGA*
Pearson, 1974: *WILL*
Havelock, 1971: *LINK*
Pelz and Andrews, 1966: *MULTI*

CREDIBILITY

Gallup, 1953: *WILL*
Holland, 1971: *LINK*
Allen, 1966: *ORGA*

WILLINGNESS

Maier, 1964: *REWA*

WILLINGNESS (Continued)

Mock, 1974: *REWA*
Rogers, 1969: *LINK*
Schon, 1967: *ORGA*

DISTRIBUTION

Aims, 1965: *DOCU*
Allen, 1966: *ORGA*
Menzel, 1964: *DOCU*
Cole, 1973: *DOCU*
Robertson, 1970: *CAPA*
Utterbach, 1971: *PROJ*
Wright, 1966: *WILL*

PROJECT

Rogers, 1969: *LINK*
Foster, 1971: *DIST*

LINK

Peters, 1975: *REWA*
Havelock, 1971: *MULTI*
Havelock, 1973: *MULTI*
Lambright, 1974: *MULTI*
Wells, 1964: *MULTI*

REWARD

Cetron, 1974: *WILL*
Pelz and Andrews, 1966: *MULTI*

AUTHOR INDEX

The following is a list of the authors that appear in the text. Page numbers in italics refer to the page upon which an annotation of an article by the referenced author can be found.

PART III

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